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Notes on Control of Weevils in Wheat.

By C. F. H. Jenkins, Government Entomologist.

INTRODUCTION.

A considerable amount of experimental work has been carried out recently by workers all over the world in an attempt to combat the weevil problem in stored wheat.

The ensuing experiments have been conducted locally and although the results cannot be regarded as final, sufficient information has been gathered to warrant its publication so that farmers and others may avail themselves of the conclusions reached and possibly be saved the time and expense of trying treatments already found ineffective.

In a recent article in this Journal, I outlined the habits and life-histories of our major grain pests and so do not propose to deal with those matters any further. I must stress again however the necessity for scrupulous sanitation in all matters connected with the storing of grain. The dust and liquid treatments which are about to be detailed must be regarded only as complementary measures to the first great essential—that of thoroughly cleaning out all containers and destroying infested refuse.

The experiments may be dealt with under two main headings—*Liquid Insecticides* and *Dusts*.

LIQUID INSECTICIDES.

The liquid insecticides can be used either for spraying out sheds, bins, trucks, etc., or for dipping bags, liners, etc. When spraying, it should be realised that the more powerful the pump is the better will be the results obtained; also, it is essential to spray thoroughly all portions of the truck or bin receiving attention as the sprays in question are what are known as contact insecticides and must hit the insects to prove effective.

A large number of liquids have been tested primarily with a purpose of finding a suitable dip for bags and liners, but any which are suitable as dips will also prove useful sprays.

The method of testing was to confine from 30-50 weevils (*Calandra oryzae*) in a piece of wheat sack and submerge them in the liquid for a specified time. The bundles were then allowed to drain for 24 hours when the weevil's were removed into a tube and the mortality noted. The mortality figures were again checked later to ensure that no recoveries had taken place.

In addition to various insecticidal and other solutions, dipping in pure water was tried as a control and also to test the limits of endurance of the insect.

The results of this experiment are as follow:—

Water.

Time Dipped.	Dead. (Per Cent.)
10 minutes	2%
7 days	10%
12 days	34%
16 days	100%

White Spraying Oil.

Although primarily prepared for use against insect pests of fruit trees, this oil has been shown to be very effective against weevils. A long series of experiments was conducted and the strength was varied from 1 part of oil to 30 parts of water to 1-200. The higher concentrations, as might be expected, gave the best results, but solutions of 1-60 proved most satisfactory, and even at 1-100 a high mortality was usually obtained. The time of dipping was varied from 10 minutes to one hour but the results did not show any marked increase in efficiency over 15 minutes, so that providing bags, etc., are not packed tightly so as to impede penetration, this time may be taken as a minimum.

Kerosene Emulsion.

This home made mixture proved most encouraging and if carefully prepared is an inexpensive and efficient insecticide. The emulsion was mixed at strengths varying from one part of emulsion to 15 parts of water to 1-30 and a mixture of 1-20 was found to be very effective. The time of dipping was again varied and 15 minutes was found to be satisfactory.

Red Oil.

This, like white oil, was primarily prepared as an insecticide for fruit trees but for use during the dormant period. Parallel experiments were run with Red and White oil at strengths varying from 1-100 to 1-200, but although the Red Oil had quite a considerable insecticidal value, it was so inferior to White Oil that it is not recommended if the latter is available.

Pale Spray.

This is another dormant fruit tree spray. It, like Red Oil, was inferior to White Oil, although moderately effective.

Home-made Creosote Emulsion.

This emulsion was tested at 1-50 for 15 minutes and one hour and very variable results were obtained. Some good kills were registered but these were off-set by some unaccountably low death rates.

Proprietary Creosote Emulsion.

This emulsion was tried at 1-50 and 1-75 for 15 minutes and one hour, but as with the home-made emulsion, the results did not show a consistently high mortality.

Condy's Crystals.

A ¼ per cent. solution was tried for 10 minutes, but as no deaths resulted the experiment was not continued further.

Formalin.

Commercial Formalin was tried at 1 per cent. for 10 minutes with only a 2 per cent. mortality and still further proof of its inefficiency followed a 100 per cent. recovery from dipping for one hour in a 3 per cent. solution.

Black Leaf 40.

Black Leaf 40 at 2 teaspoonsful plus one ounce of soap to the gallon of water gave only a 2 per cent. mortality and so was not tested further.

Copper Sulphate (Blue-Stone).

A 6 per cent. solution of Blue-Stone was tested for half an hour and one hour but the highest mortality obtained was only 14 per cent.

Hot Water Treatment.

Weevils are killed comparatively easily by heat and where containers or bags can be treated with boiling or nearly boiling water, weevils will be successfully killed. It was found that dipping for 15 minutes in water at 140° F. was sufficient to kill weevils but for practical purposes when large numbers of bags are being dipped, the water should be maintained as near boiling as possible.

Sheep Dip.

Immersion in a proprietary arsenical sheep dip at the strength prescribed for dipping sheep was tried for periods of ten minutes and one hour, 100 per cent. recovery occurred in both instances.

A word of warning may not be out of place to those who may have tried various dips with apparently satisfactory results. Frequently after being removed from a dip, weevils appear quite dead and the unwary experimenter is liable to be misled. The only sure test is to keep the apparently dead insects under observation for 24 or 48 hours. The percentage of recoveries which take place during this period is often astounding.

It will be readily apparent that there are a number of considerations which govern and restrict the choice of insecticides. Firstly, they should be effective in destroying the insects. Secondly, they must not be too expensive. Thirdly, they must not taint or adversely affet the grain. Fourthly, they should not increase the fire risk.

Items 2 and 4 are serious draw-backs to the use of Kerosene-pyrethrum sprays which are undoubtedly effective weevil killers, and item 3 rules out arsenical ones even if effective.

None of the mixtures used gave consistent kills of 100 per cent. but Kerosene Emulsion and White Oil were the only ingredients to ever achieve this percentage,

and as the results obtained with both were usually high, they are to be recommended. The other oil sprays and Creosote Emulsions, although giving inferior results to the above-mentioned dips, have certain properties as weevil killers. The remaining mixtures may be regarded as quite ineffective.

Preparing Kerosene Emulsion.

A little care is necessary in preparing this emulsion to prevent the kerosene rapidly separating out and floating on the water, but quite a satisfactory mixture can be made if the details are followed with reasonable care.

First, dissolve ½ lb. of soap in one gallon of boiling water. Remove from fire but while still hot pour slowly into the soap solution two gallons of kerosene. The mixture should be violently churned and stirred while the kerosene is being added to get a thorough mixture. A milky emulsion will result which can be kept for long periods if properly prepared. This mixture may then be used as prescribed at the rate of one part of emulsion to 20 parts of water. Care should again be taken to thoroughly agitate the mixture while it is being diluted. Although as stated the stock emulsion will keep for future use, there will be less chance of the kerosene separating out if it is used when mixed.

Creosote Emulsion.

The same particulars apply to the preparation of this mixture as to the kerosene emulsion, creosote being substituted for kerosene. The whole secret of getting a good emulsion is to thoroughly agitate the ingredients when they are being mixed. If hot water can be used throughout so much the better.

DUSTS.

A number of so-called inert dusts have been shown to possess remarkable insecticide properties. One of the first to gain recognition was a proprietary silica dust known as "Naaki Dust," which has been widely tested in Germany and Russia. There seems to be some doubt as to how death is actually caused; some contend it is by the mechanical action of the dust entering the joints, etc., of the insects, while strong support is given to the theory that the dusts kill by their drying or desiccating action.

A wide variety of local dusts have been tested and all excepting two were ground so as to pass through a 200-mesh sieve. The diatomaceous earth was ground with a mortar and pestle; the iron pyrites residue was used as obtained.

The method of testing the dusts was to mix them at varying rates with clean wheat and add 50 weevils. Counts were taken at fixed intervals and the mortality noted.

The materials tested included ground quartz, diatomaceous earth, clays (several types), magnesite (several types), rock phosphate, borax, residue from roasted pyrites and salt.

Ground Quartz.

This dust was microscopically examined and 70-80 per cent. of the particles were 10 microns or under, the remainder going up to 50 μ. The most effective kills were obtained with a 1 per cent. concentration, and although the results varied considerably, some satisfactory results appeared.

Diatomaceous Earth.

This material was calcined and ground with a mortar and pestle. Microscopically it showed that 90 per cent. of the particles were below 10 μ with some of the longer spicules and diatoms reaching a length of from 30-50 μ. The rate was varied from 1 per cent. to 1/16th per cent. by weight and over the whole series of experiments very good results were shown, the percentage kill varying from 90-100 per cent. in seven days.

Clays.

Three clays of the bentonite type, collected from Bardoc, Watheroo and Collie, were tested at 1 per cent., but the results were not sufficiently encouraging to warrant further investigation.

Magnesite.

A hard and soft type of magnesite from Coolgardie were tested at 1 per cent. against a sample kindly supplied by the Council for Scientific and Industrial Research. Of the local dusts, the soft type was the more effective but was considerably inferior to the third sample against which it was being tested.

Calcined Magnesite.

When freshly calcined this material was most effective, giving kills of 100 per cent. in seven days, but after being kept for some time it recombined with moisture, became lumpy and less effective.

Rock Phosphate.

This dust gave quite good results.

Residue from Roasted Pyrites.

Variable results were obtained in the main comparable with those obtained by the soft magnesite.

Sodium Chloride.

Salt dried and ground was tested at 1 per cent., but proved quite ineffective.

Borax.

Although possessed of some lethal properties, it was inferior to several other dusts and much more expensive.

From the foregoing it will be seen that by far the most effective dust tried was the calcined diatomaceous earth. This was followed by the ground quartz. It is desired however for health reasons to find a suitable non-siliceous dust which will give effective control to weevils, and consequently experiments are still being carried on with magnesite and other likely materials.

To give the best results, a dust should be mixed with the wheat before it becomes infested, as when the grain becomes damp and weevily the efficiency of the dust is greatly reduced.

Does the number of weevils introduced into a clean sample affect the efficiency of the dust?

To test this matter, 50 weevils were placed in 200 grm. of clean wheat and 400 weevils in 60 grms. of wheat. The experiment was replicated and diatomaceous earth used at ¼ per cent. and ⅛ per cent., but no significant differences were obtained as from 90-100 per cent. mortality resulted in all cases within 7 days.

Does the amount of weevil flour and frass affect the efficiency of the dust?

To answer this question, samples of clean wheat were treated with 1 per cent., 2 per cent., 4 per cent., and 8 per cent. by weight of wheat dust sifted from badly infested wheat. The samples, including a control of clean wheat, were treated with ½ per cent. diatomaceous earth and no significant differences in the rate of mortality were obtained.

The reason why the weevil population in badly infested wheat is not rapidly reduced by the addition of dusts, appears to depend on a number of factors.

First of all the presence of numerous insects may raise the moisture content of the grain and so reduce the efficiency of the dust. Secondly, many of the weevils may be feeding in chewed out grains where they are less likely to come in contact with the dust, and lastly, the eggs and larvae already in the grain will continue to develop and replace those already killed by the dust.

In order to test these points, a sample of weevil infested wheat was sifted so as to remove all the dust and adult weevils. The live weevils and wheat dust were then replaced in the sample, together with ½ per cent diatomaceous earth. Counts showed that in a little over a fortnight, death had accounted for a quantity of weevils equal to the number originally added; there were still however a large number of live weevils present. Successive counts revealed a continued mortality coupled with quite a high living population accounted for by fresh emergences. This experiment is still in progress and the final results are not yet available, but it shows clearly that the dust treatment should be regarded more as a preventive than a cure and that it is difficult to control by this means an infestation once it is firmly established.

Dusting bins, containers, etc.

Where dusts are used for treating bins, sheds, bags, etc., the first essential is to see that all refuse and old wheat has been swept up and destroyed and not just thrown outside. The dusting too must be done thoroughly so as to penetrate into all cracks and crevices. If the treatment can be given with a dust gun, so much the better. If dust is used on weevil infested bags, the latter should be turned inside out and thoroughly shaken and freed from grain, etc. The dust should be then shaken all over the bag and especially into seams and corners. It must be realised that just to sprinkle dust over an untidy heap of bags or between the bags is useless; each bag must be treated individually and thoroughly. The mortality resulting from dust treatment is usually slow, perhaps taking two or three weeks, so that bags likely to contain weevils had better be subjected to one of the more effective liquid dips or fumigation if they are wanted for immediate use.

SUMMARY.

Control weevils by:—

1. Thoroughly cleaning out bins, trucks, bags, etc., before putting in fresh wheat.
2. Destroying all refuse; don't merely throw it outside.
3. Shaking and turning bags after use and hanging them over a wire instead of piling them on the floor near the old wheat.
4. Treating infested bags by dipping in boiling water, White oil, Kerosene Emulsion, or other effective dip, or by dusting.
5. Keep all wheat as dry as possible.
6. Do not mix old and new season's wheat.

ACKNOWLEDGMENTS.

In carrying out the foregoing experiments, I am greatly indebted to the Government Analyst and Mineralogist, Mr. H. Bowley, for providing and grinding various dust samples. Much of the work of counting and sorting the weevils has been done by the Assistant Entomologist, Mr. P. N. Forte, to whom my thanks are also due.

Management and Housing of the Pig Under Wheatbelt Conditions.

W. M. NUNN, Agricultural Adviser.

A great deal has been written and said about the housing of pigs in dairy districts, but very little designing has been done for the wheatbelt areas. The intensive method of sty feeding seems to have been accepted as the general thing, but it is difficult to decide why this should be so. Perhaps the method is unthinkingly copied from the dairy districts or from other countries where space is limited, or perhaps it is thought that solid wooden fences are essential to confine the pig and the project of building roomy yards of this type of construction is too formidable. The solid fence is necessary if the pig is asked to live in a few square yards, but if given room to move about, a netting or mesh fence, with a barb on the ground and another half-way up will be found quite efficient.

When the wheatbelt farmer makes a start in pigs he generally does so with some repugnance. He regards the pig as an unwholesome and dirty animal which lives in a few square yards of malodorous filth. Why the pig should have chosen such a distasteful mode of life is a question that seldom presents itself until by accident the farmer sees for himself a properly run pig farm where the animals are given plenty of room.

Those poky little 10 feet by 8 feet enclosures are all right if used as farrowing pens only, and then only if they are cleaned regularly and disinfected thoroughly after each use. The trouble is that the usual wheatbelt sty, built of bush timber or sleepers with an earth floor and generally poorly drained, cannot be disinfected and so cannot be prevented from becoming a harbour for disease germs and worm eggs.

Most wheat farms are a thousand or more acres in extent, so why not give a few acres instead of a few square yards to the pig herd? Let each sow have something approaching a quarter of an acre to herself and her litter, and let her rear them in that yard without contacting any other pig which might be a disease carrier.

There are three systems of pig raising:—

(a) the open range or paddock system;
(b) the inside or intensive system;
(c) a combination of (a) and (b).

For the wheatbelt farmer, the paddock system is recommended. The combination of the outdoor and the indoor system is used very satisfactorily on a number of up-to-date wheatbelt piggeries, where the owner is in a sound reliable district, and where he is not handicapped by lack of finance and shortage of

labour, but for the average wheat farmer who is now setting out to partake of the still promising returns from the bacon market, to build farrowing pens and expect to keep them clean is merely to ask for trouble. Remember that those who are well established with well drained cement floors and with white-washed walls to their farrowing pens still have to wash them out regularly and scrub and disinfect them prior to each use if they are to be sure of avoiding contamination. They have water laid on and abundant labour to carry out this work, but what chance has the average wheat farmer who is now starting pigs in a comparatively small way, doing all his work himself and carting water, of giving this attention to his sties.

The small pig breeder under wheatbelt conditions therefore, must get right away from the old idea of permanent farrowing pens. He can confine the sow in a pen for farrowing if he is unable to provide her with a separate yard, but it should be a temporary or movable pen so that the same site is not used again and again by sow after sow.

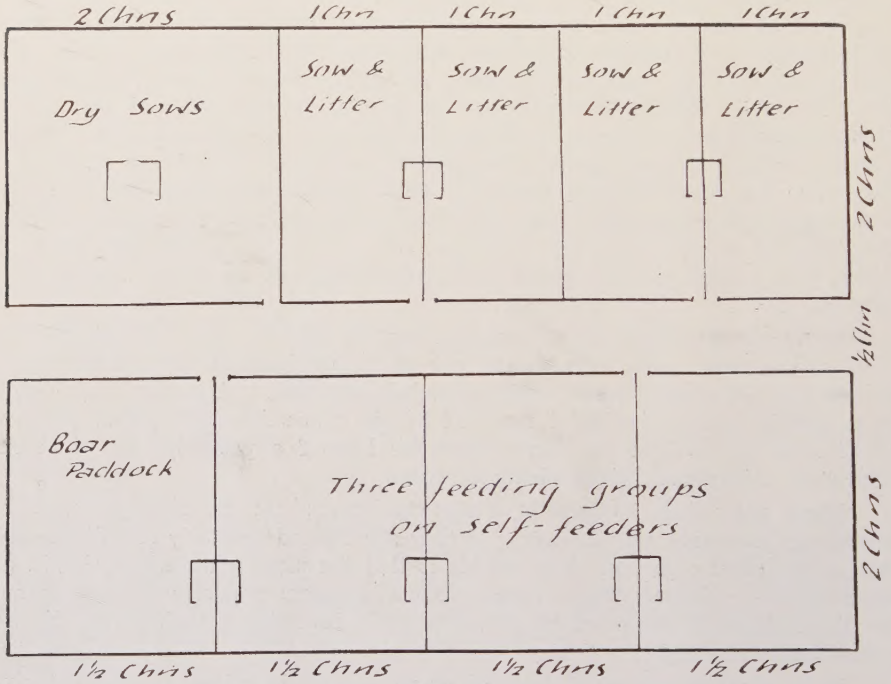

Fig. 1.
Suggested layout for piggery on the paddock system recommended for wheatbelt conditions.

Site.

In selecting the site for the pig yards every attention should be given to drainage and protection from the weather. A sandy type of soil should be chosen rather than a heavy clay type, and it should have sufficient slope to ensure that there will be no residual water after rains. If possible it should be sheltered by timber on the weather side.

Layout.

A suggested layout is shown in Fig. 1. This could be varied considerably to suit the site and the size of the herd, but note the size of the unit. Each sow is to be given a yard one chain by two chains for herself and her litter. The

roomy race between the runs allows easy movement of pigs from yard to yard and with the provision of a few hurdles to span it all the facilities for drafting are provided.

This system of yards could be worked on a slightly smaller scale if finance is limited, but in the long run the larger paddocks will show to considerable advantage.

The ideal layout under the paddock system would provide for the establishment of pastures in these paddocks. It is not intended here to say what should be grown because the possibilities in this respect will vary considerably with the district and the season. Some will be able to plant subclover, peas, lupins, etc., while those in the drier areas could not do better than plant occasionally some wheat, oats or barley. The amount of grazing obtained might be very slight, but the benefit of an occasional working is inestimable from the point of view of cleanliness.

The advantages of the large yards over small cramped quarters are many. They allow of cleanliness in management and a certain amount of grazing as mentioned above. They allow for cleanliness and comfort on the part of the pig, which is naturally a clean animal if given the opportunity, and above all they provide the surest safeguard against disease.

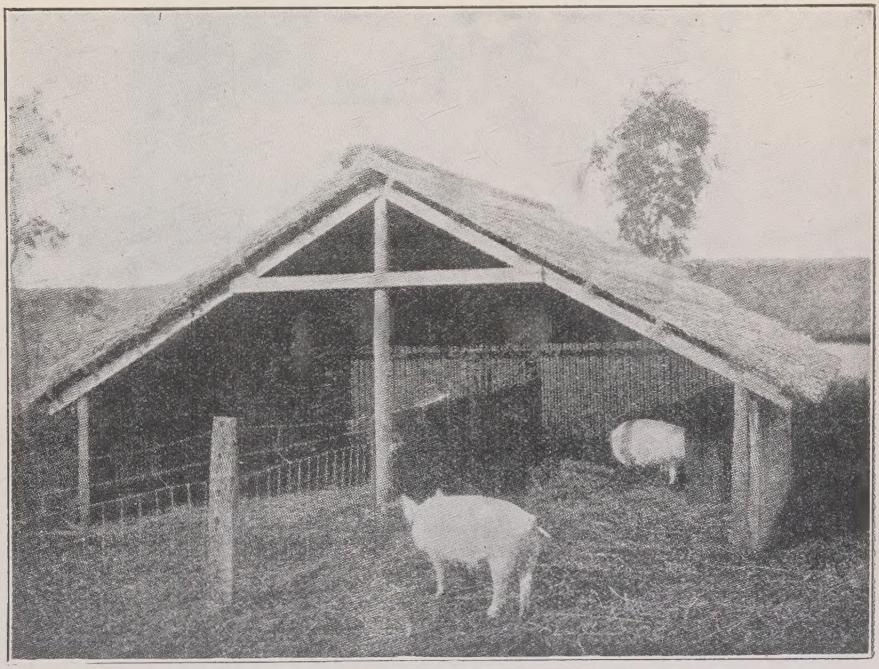

Fig. 2.
Type of shelter used at the Northfield Farm of the Inspector-General of Hospitals, S.A.
[From Journal of Agric., S.A., April, 1940.]

Shelters.

A warm draughtproof shelter should be provided in each of the yards. It need not be elaborately constructed, but it should be roomy, well ventilated and entirely free from draughts. The pig is very sensitive to cold and draughty conditions, and serious disease can result from the lack of proper sleeping accommodation.

Again, when the animal has difficulty in keeping warm a large proportion of the food eaten is used up in providing heat instead of contributing to body weight.

Shelters can be economically constructed in the wheatbelt from bush timber, roof and siding with galvanised iron, scrub or straw. Fig. 2 shows the type recommended for use with the layout in Fig. 1. It should be high enough to permit a man to enter comfortably for cleaning purposes.

A cool, airy shelter of the type shown in Fig. 3 should also be provided for the comfort of the pig under heatwave conditions. A clean wallow, like the clean farrowing pen, is a practical impossibility, in most areas of the wheatbelt, and the type of shelter illustrated with a good depth of straw roofing provides a cool, comfortable spot for the pigs during the heat of the day.

Fig. 3.
A cool airy shelter. Better than any wallow in providing for the comfort of the pig in the heat of the wheatbelt summer.
[W.M.N.]

Farrowing.

The sow should be put in her yard at least a week before farrowing so that she may become accustomed to her quarters. She should be allowed to farrow in the shelter provided and to live with her litter in this yard until it is time to wean at about 8 or 10 weeks. She will not make a mess of this shelter, because with the room provided she will be able to exercise the cleanly habits that are naturual to her. It is not suggested that this method is better than the correct use of clean cement floored farrowing pens, but is certainly much better than using the unhygienic disease-harbouring sties which are so prevalent in wheatbelt areas.

Creep Feeding of Litters.

At about three weeks the young pigs commence to forage a little for themselves, and a creep feeder should be provided so that they may supplement the mother's milk as early as possible and become accustomed to the diet they are to go on to after weaning. A creep can be constructed in a dozen different ways and directions are hardly necessary. It is required only that the young pigs can get to the trough while the sow cannot.

Weaning.

At weaning it is best to leave the young pigs in the yard to which they have become accustomed and to remove the sow. The weaners will be less upset and will receive less check this way than they will if they are removed to another yard and meet other pigs. It would be necessary to leave them in the yard only for a few days until they have settled down to their new diet, and they could then be joined with other weaners on the same ration.

Group Feeding According to Weight.

Rations for pigs of various ages or at various weights have been set out in earlier departmental publications. To enable these rations to be correctly supplied it is necessary to group the pigs from weaners upward according to their weights. Pigs from weaning to 50 lbs. live weight should be fed in one yard on the ration suitable to them. From 50 lbs. to about 80 lbs. the ration should contain a lower portion of protein, consequently the pigs of this class should have a separate yard if possible. From 80 lbs. live weight to the finishing baconer, the ration should be a little wider still and should include some chaff to avoid over fattening, and so this group should also be fed separately.

Self-Feeders.

There is no reason why self-feeders should not be used for all groups of grow ing pigs. The ration recommended for wheatbelt feeding is composed of crushed or ground grain, meatmeal and lime with the addition of chaff in the later stages.

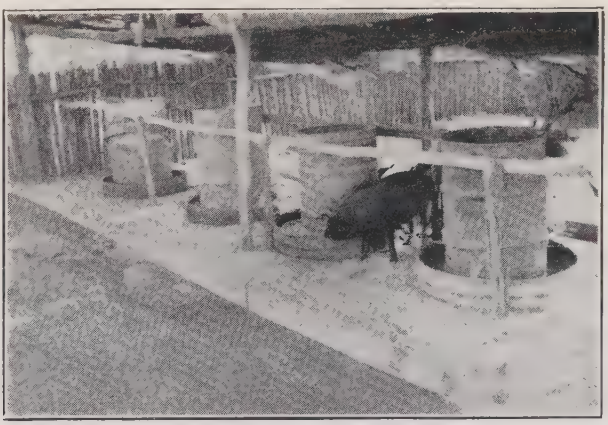

Fig. 4.
A group of self feeders made from 44-gallon oil drums in use on Mr. J. Borlase's farm north of Mukinbudin.
[W.M.N.]

The ration is best fed dry, and it can be mixed in the correct proportion for each group and fed through the self-feeder, provided, of course, that a separate feeder is used for each weight group. An enormous saving in labour is thus obtained, and the growing pig is more economical in the use of his food if allowed thus to obtain it as he wants it, instead of fighting hungrily for as much as he can get when the trough is filled twice a day. It is often contended that there is much waste from a self-feeder, because the dry grain is nosed out on to the ground. If the trough is made fairly deep with vertical sides, grain cannot be nosed out of it, and the only grain spilled will be that dropped from the mouth of the pig as it

walks around the trough between mouthfuls. A useful way of minimising this spilling is to erect the feeder on a pedestal 6-8 inches high. Construct it so that the pedestal is only slightly larger in diameter than the trough, leaving only a narrow ledge all round. If the pig has to climb with his fore feet on to this ledge in order to reach the feed, he will stay and eat over the trough rather than climb up and down for each mouthful.

In the construction of the feeder care should be taken to see that the pig cannot comfortably put his feet in the trough itself; that the whole unit is supported on a solid floor properly drained, and that it is roofed so that the feed in both container and trough is kept clean and dry.

For the farmer who expects to do his own cropping and sheep handling and still rear a few baconers, the self-feeding method appears to be the only one. A group of home-made self-feeders is shown in Fig. 4.

Fig. 5.
Pig yards under wheatbelt conditions showing lay-out on the paddock system.
[W.M.N.]

Hand-Feeding for Boars and Sows.

Sows and boars should never be put on self-feeders, or they will become too fat. They should be hand fed and the quantity should be so adjusted that the animals keep in healthy condition. The amount fed should never be more than the animal can comfortably clean up, and the trough should be cleaned out before the next feed is placed in it.

The boar should be provided with a separate yard, and sows should be taken to him as required. Many farmers get on all right by running the boar with the dry sows, and if fences are not the strongest this probably saves a lot of trouble. It is advisable, however, to keep him separate if possible, particularly if the proportion of sows are high and demands on him heavy.

Yarding Provisions.

If above requirements are to be met, it will be seen that the layout should provide for: Sufficient yards to accommodate milking sows as they come in, a yard for the boar, a yard for each of three feeding groups on self-feeders and a

yard for dry sows. This will seem a lot to the farmer starting in a small way, but he should remember that his pig-rearing is to increase, and he should visualise a productive future for it and allow for ultimate expansion to this type of yards, even though his intitial construction is only a small part of it.

Green Feed.

In the drier areas of the wheatbelt very little grazing is available except for about three months in late winter and early spring. That pigs can be satisfactorily and payably reared from weaning to baconers without any green feed has been amply demonstrated. Nevertheless, green feed is the most healthgiving of all foods, and should be supplied by some means or other wherever possible.

Particularly in the case of the brood sow is green feed to be desired, and when grazing is not available every endeavour should be made to supply green fodder if it is only a handful a day. A small irrigated patch of lucerne or other summer-growing fodder is of inestimable value throughout the long, dry, wheatbelt summer.

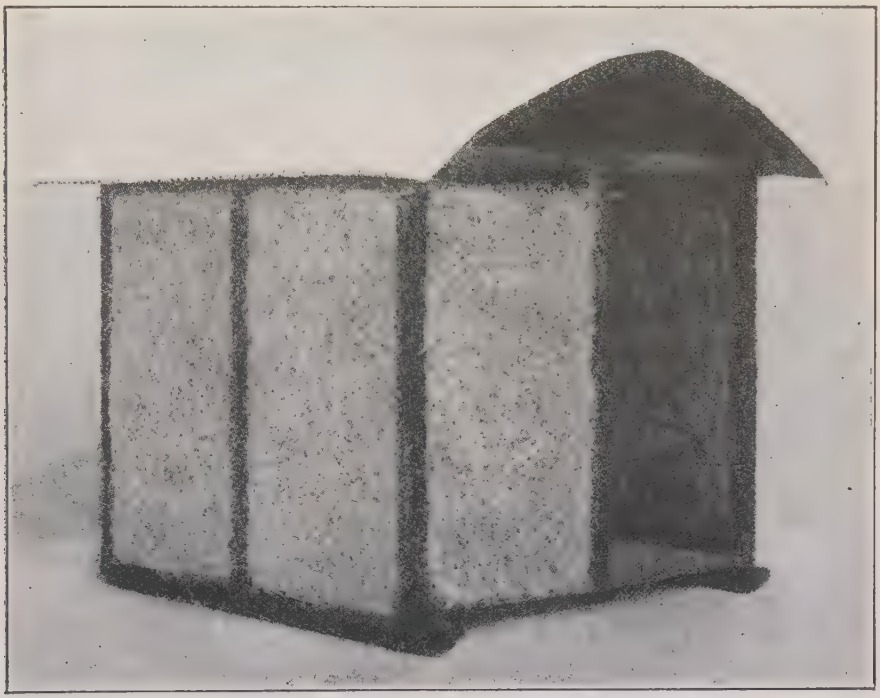

Fig. 6.
Movable shelter with walls of netting packed with straw.
[From Queensland Ag. Journal, Jan., 1939.]

Electric fencing now enables the farmer to obtain grazing for his pigs in winter and spring, by fencing patches of grass land or of crop. Farmers often seem of the opinion that the pig would simply root out the wheat plant and obtain little value from them if put on a patch of crop. The pig will not root the plants out while there is easily obtainable green picking for him, but he will if left on the same patch too long. The electric fence allows for frequent changes to new areas and enables much increased return from grazing.

Where the electric current fence is used it is necessary to have movable shelters which can be shifted about easily to wherever required. Some types of movable shelters are shown in accompanying illustrations (Figs. 6 and 7).

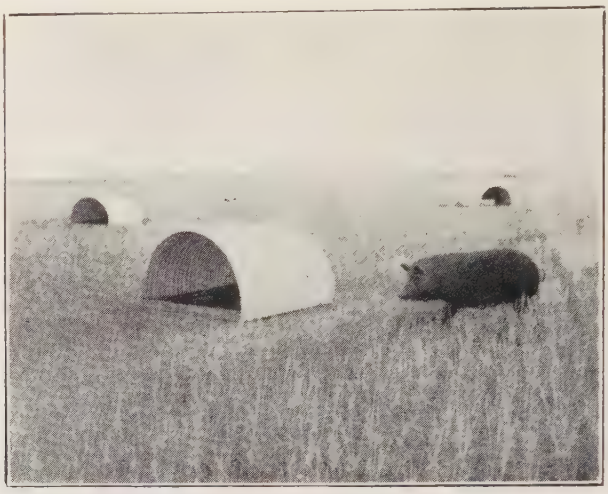

Fig. 7.
Very cheaply constructed portable shelters in use on Mr. N. F. Powell's property at Quairading. The pigs are being grazed on a crop of barley. Mr. Powell uses these shelters in conjunction with electric fencing during the winter months.
[W.M.N.]

Summary and Conclusion.

Farmers in the drier areas of the wheatbelt are already very hard worked. They do the greater part of the work of cropping and sheep management themselves, with assistance only at rush periods. Now, nothing daunted, they aim to manage a herd of pigs as well. Finance in most cases is limited, and the project is commenced in a small way with yards constructed by the farmer in spare moments. Under these conditions the construction and management of concrete sties are quite out of the question. Sties of any other description cannot help but become contaminated and so lead to ill-health in the herd, and so the paddock system of yarding pigs is strongly recommended. Roomy yards properly managed, and the intelligent use of self-feeders make it possible for the farmer under these conditions to rear profitable baconers with a minimum of expense and labour.

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Toxic Paralysis (Botulism) in Farm Animals.

C. R. Toop, Senior Veterinary Surgeon.

Introduction.

During recent years a number of articles have appeared in this Journal recording the original observations of officers engaged in investigating various aspects of the disease known as Botulism or Toxic paralysis as it affects cattle and sheep. In the preparation of this article, in which an endeavour is made to describe the disease, its causes, and the measures which may be adopted for its prevention and control, full advantage has been taken of the information which has thus been made available. Although it may be prevented by vaccination, this disease is still responsible for heavy annual losses amongst farm animals. It occurs over a large portion of the agricultural areas and losses have been particularly severe in certain of the wheatbelt districts. Sheep and cattle particularly are affected; horses to a much less extent. Other animals are highly resistant to the disease. Mortalities on occasions have been reported amongst poultry and birds. Toxic paralysis results from the consumption of material such as carrion, bones, water and fodder, contaminated with a micro organism known as *Clostridium botulinum,* which occurs widely in nature. During its growth in such material this organism produces an extremely potent toxin or poison which, if consumed by a susceptible animal, will set up symptoms of the disease, toxic paralysis, frequently resulting in the death of the animal.

Toxic Paralysis in Sheep.

Toxic paralysis in sheep is almost wholly confined to the summer months, usually making its appearance in January or February and continuing and often increasing in intensity until the onset of the autumn or early winter rains. When green feed becomes available losses from the disease cease abruptly. In sheep, the disease has only been reported during recent years. It was first diagnosed in 1928 and during the years which followed and up till the end of the summer of 1935 it was responsible for appalling losses. A conservative estimate placed these losses during a single season at more than 100,000 sheep; and cases are on record where the losses on individual properties exceeded 50 per cent. of the flock. During the same period losses amongst cattle were proportionately heavy, and in some districts it was difficult to maintain household milk supplies. Although it is not now the scourge of a few seasons ago, toxic paralysis still exacts a heavy toll and as a disease of sheep it ranks second only in importance to infectious enterotoxaemia (braxy-like disease).

Depraved Appetite and Sarcophagia.

The underlying cause of the disease is depraved appetite or pica, which develops during the course of summer and manifests itself in the form of a craving on the part of the animal for such material as decomposing animal carcases and rabbit droppings. An animal affected by this craving will seek out such material and consume it voraciously. Carrion eating is referred to as sarcophagia.

Low Nutritive Value of Pastures.

This condition of depraved appetite is directly associated with the low nutritive value of the grazing available which is especially lacking in protein and carbohydrates—two of the principal constituents of any diet. As the summer advances the

grazing steadily deteriorates in quality, and often in quantity, ultimately becoming inadequate to meet the requirements of the animal which is forced to exist on a low plane of nutrition and commences to lose condition. When this stage is reached, depraved appetite, expressing itself in a craving for carrion, develops—apparently for the purpose of making good what is lacking in the diet.

Mineral deficiency not responsible for depraved appetite.

It was at first thought that depraved appetite was the result of mineral deficiency. This view was based upon the remarkable success which had attended the use of phosphatic licks in preventing "Lamziekte" an identical disease of cattle occurring widely in South Africa. Phosphatic licks were fed extensively in this State but it soon became apparent that they had failed completely to arrest the progress of the disease. It was later shown in experimental sheep that such licks exerted no influence whatever in preventing the development of the depraved appetite.

Toxin Carrion.

The carrion (principally decomposed rabbits; less often the carcases of sheep, cattle, and other animals, left to putrefy in the paddocks) consumed by sheep suffering from depraved appetite is frequently contaminated with *Cl. botulinum.* This micro organism is widely distributed in the soil of farm lands. It often inhabits the intestines of the living animal causing no ill effects. In the living animal the organism is unable to multiply and produce its toxin. When the animal dies, however, and the carcase commences to putrefy it quickly becomes invaded by the organisms contained in the intestine, which now multiply rapidly and at the same time produce a powerful toxin or poison. In a similar manner a decomposing carcase may be rendered toxic as the result of invasion by *Cl. botulinum* contained in the soil with which it is in contact. Sheep consuming such toxic carrion will, after a brief incubation period, develop symptoms of toxic paralysis accompanied by a high rate of mortality.

Decomposing rabbit carcases do not usually become attractive to sheep until 8-10 days old and at this stage they may prove highly toxic. Some conception of the potency of the toxin will be gained from the fact that as little as 1/10 of an ounce of such a carcase may prove fatal if consumed by a sheep. This toxicity steadily diminishes with age but contaminated carcases may still prove dangerous and able to kill sheep even after a period of six months, particularly if they have been shaded after sinking down in the stubble or buried in a burrow or warren and subsequently unearthed.

Polluted water.

Water which has become polluted by a putrefying animal carcase may be rendered highly toxic. Some severe outbreaks of toxic paralysis have been traced to this source.

Contaminated fodder.

On occasions *Cl. botulinum* is enabled to multiply and produce its toxin in vegetable matter. This may occur in the mouldy discoloured sheaves present in the butt of a stack. Chaff cut from such hay may prove highly toxic. In addition, chaff cut from mice infested stacks may be rendered toxic as the result of the bodies of dead mice passing through the cutter. Mortalities associated with contaminated chaff have been observed when this fodder has been fed to sheep as

a supplementary ration during the summer. In some instances chaff which has been proved to be toxic as the result of laboratory tests, has appeared to be of prime quality and in these cases it has not been possible to determine the origin of the toxin.

Rabbit droppings non toxic.

Contrary to a widely held belief that the consumption of rabbit droppings by sheep may result in toxic paralysis, field experiments in which large amounts of droppings were consumed by sheep, have given entirely negative results. These droppings were collected on a number of properties where the disease was actually occurring and the experiments definitely proved such material to possess no toxic properties. Although tests have not been made, the position is probably the same in the case of fowl droppings which are relished by cattle.

The rabbit pest.

Toxic paralysis in Western Australia has been closely linked with the rabbit pest and the years in which the greatest mortality from the disease has occurred have coincided with the years in which rabbits have been present in greatest abundance. The effect of the rabbit in this connection has been two-fold. Firstly by the eating out of pastures it has hastened the rate of their deterioration and has thus contributed to the development of depraved appetite. Secondly the poisoning operations necessary to control the rabbits have provided toxic carrion in great abundance and easily accessible to the sheep. Thus the rabbit has largely provided the conditions essential to the development of the disease and it is probably safe to say that, in the absence of the rabbit, toxic paralysis would cease to be a problem of serious importance in this State. In comparison mortalities resulting from the consumption of carrion derived from other sources (dead sheep, cattle, etc.) are relatively rare. It should not now be necessary to add that the poison bait responsible for the death of the rabbit has no direct association with the development of toxic paralysis. For this to occur it is an essential condition that the carcase become invaded by *Cl. botulinum.*

Symptoms in Sheep.

Affected sheep usually die within two or three days after the appearance of symptoms. They separate themselves from the flock and may be found lying in the normal recumbent position or standing with the head held low. Such an animal, if kept under observation, may periodically be observed to wriggle its tail spasmodically as though flystruck. This is a quite characteristic symptom. When it is driven, the gait of the animal is stiff and short, the back is somewhat roached and the head may wobble up and down. After proceeding a short distance, the animal lies down suddenly as though fatigued. After a short rest it may be induced to rise and will repeat this procedure. Towards the end the animal is unable to rise, and lying in the normal recumbent position, dies quietly without struggling. In some instances a flow of saliva from the mouth may be observed, but salivation in the sheep is by no means a frequent symptom. Occasionally affected animals may linger for a week or more, and in some cases recovery may occur.

The Prevention of Toxic Paralysis in Sheep.

Mineral licks do not prevent the development of depraved appetite, nor do the food supplements such as wheat, oats, chaff, hay or silage, which are frequently made available to sheep during summer in order to maintain their condi-

tion. Consequently these supplements are not effective in the prevention of the disease. Wheat and oats do, however, somewhat delay the development of the craving. It is interesting to note, however, that depraved appetite may be entirely prevented by the feeding of a complete ration, i.e., a ration which will supply all the nutritive requirements of the animal and will therefore contain adequate amounts of protein and carbohydrate. The feeding of such a ration, however, has no practical application on account of its high cost. Two methods of control may be practised, viz.:—

1. By the control of rabbits and the destruction of carrion.
2. By protective inoculation.

The latter method is more generally applicable and is very effective.

Prevention by the Control of Rabbits and Destruction of Carrion.

By enclosing a property with a rabbit-proof fence, carrying out an intensive campaign of rabbit destruction thereafter keeping the rabbit population to a minimum by appropriate measures, meanwhile gathering together and burning all carcases, it is possible to effectively control toxic paralysis. This has been achieved on a number of properties where formerly disastrous losses were sustained. Not only has the disease been eradicated, but the carrying capacity has increased and the sheep have been enabled to come through the summer in much better condition. Such control measures, however, are not always practicable, being limited by such factors as lack of finance and the difficult nature of the country with which it may be necessary to deal. Their application, nevertheless, should always be the objective of all stock owners.

Prevention by Inoculation with Botulinus Toxoid.

Toxic paralysis may very effectively be prevented by inoculation with a vaccine known at botulinus toxoid. This product is prepared from cultures of *Cl. botulinum* grown in the laboratory, subsequently killed by the addition of formalin and then precipitated by the addition of alum which ensures slow absorption from the site of injection thus provoking a powerful immunity response. The immunity or protection against the disease, conferred upon an animal inoculated with botulinus toxoid, is of an extremely high order. In experiments carried out by this department inoculated sheep have been given, without suffering any ill effects, 5,000 times as much toxin as would kill an untreated animal. Such being the case it is extremely unlikely that under field conditions a sheep would ever consume sufficient toxic carrion to break down the immunity which inoculation has conferred upon it.

Sheep should be inoculated at the commencement of summer in order that they may enjoy the highest degree of protection when the danger is greatest. The maximum of immunity is reached 30 days after the completion of inoculation but it is quite strong after an interval of 10-14 days. In addition, the immunity is a lasting one and persists for more than two years. It gradually wanes, however, and as it is desirable that immunity should always be maintained at the highest possible level, annual inoculation is recommended. The cost of treatment is relatively small. Based on a flock of average size it is somewhat less than one penny per head. The dose of botulinus toxoid for the sheep is 5 cc. given in a single injection. This is popularly known as the "one shot" type of vaccine which serves to distinguish it from that type of vaccine with which two injections are necessary It has the advantage of obviating double handling so reducing labour costs.

Inoculation of Sheep.

It will be found most convenient to inoculate sheep in a small yard capable of accommodating not more than 50 animals, which can be filled as required from larger yards adjoining it.

The following equipment will be required:—a 20 cc. "Record" hypodermic syringe contained in a metal case, six spare No. 18 veterinary hypodermic needles, and a quantity of cotton wool and methylated spirits. Before use the syringe must be sterilised by boiling. To avoid cracking, the metal plunger is withdrawn from the glass barrel. Together with metal case and spare needles the syringe is placed in a vessel of cold water, brought to the boil and kept boiling for five minutes. On cooling, the syringe may be assembled and the needle attached, care being taken to handle only the outside portion of the barrel, the plunger by the handle and the needle by its butt. This will prevent contamination by the fingers of those portions which will come in contact with the vaccine and would otherwise undo the work of sterilisation. Spare needles should be placed in a cup or other vessel containing methylated spirits and will serve as sterilised replacements should the needle in use become soiled or damaged. The syringe case which has been boiled will serve as a sterilised container for vaccine which may be added to it from the bottle as required. The lid will serve as a cover to exclude dust from the yards and must only be removed during replenishment and when the syringe is being recharged. The vaccine will be noticed to contain a heavy precipitate (deposit) which is the active principle and the bottle must always be shaken before the removal of its contents. Vaccine which has been opened but unused at the completion of operations should be discarded. The equipment and vaccine should be placed on a small table, packing case, etc., in a position outside the yard where it will not suffer damage from the sheep and will be within easy reach of the operator. It will be found convenient and confusion will be avoided if the sheep are inoculated in close proximity to the gate and are released as treated, into an adjoining yard. Sheep should be held in the same position as for crutching and the injection for preference should be made in an area devoid of wool such as the inner surface of the thigh or the brisket. The latter site is generally preferred. When the syringe is filled to the 20 cc. mark it will contain sufficient vaccine for the treatment of four sheep. Air bubbles should be expelled by gentle pressure with the finger when the syringe is held upright. The skin at the site of inoculation is cleansed by swabbing with cotton wool steeped in methylated spirits. A fold is taken up between the thumb and forefinger and pierced by a thrust with the needle. The needle should not penetrate deeply but should lie immediately beneath the skin where it can be felt. The required dose of vaccine is then injected by pressure on the plunger.

Apart from slight lameness which may persist for a short period following treatment, inoculated sheep suffer no ill effects. A firm nodule develops at the site of inoculation and a period of months may elapse before it is completely absorbed.

Every precaution must be taken however, to prevent the introduction of infection with the vaccine. Such an eventuality might be followed by considerable mortality. The measures outlined above including the sterilisation of syringes and needles, exclusion of dust from the vaccine, and cleansing of the skin are designed for this purpose.

Measures necessary to Control an Outbreak of Toxic Paralysis.

Should an outbreak of the disease occur amongst uninoculated sheep, inoculation with botulinus toxoid should immediately be performed. After an interval of 14 days an immunity sufficiently strong to prevent further losses will be estab-

lished and the sheep may then be exposed to infection with impunity. In the meantime the paddocks should be searched for carrion which should be gathered and burned. Better still the flock might be moved to a small paddock known to be carrion free and hand fed until the vaccine has taken effect.

Treatment of toxic water.

If the outbreak has been traced to the consumption of water polluted by carrion this may be detoxicated or rendered harmless by the addition of quicklime at the rate of 2 lbs. to 40 gallons after the decomposing carcase has been removed.

Where contaminated fodder has been proved responsible a fresh source of supply should be sought.

Toxic Paralysis in Cattle.

Toxic paralysis appears to have affected cattle in this State for many years and records of its occurrence are available as long ago as 1896. As in the case of sheep, losses from the disease are principally confined to the summer. The same causes which have already been described in some detail operate, viz., depraved appetite resulting from the low nutritive value of the grazing available during summer followed by the consumption of toxic carrion. The consumption of polluted water or contaminated fodder may on occasions also be responsible.

Osteophagia.

In cattle, however, mineral deficiency appears to be a complicating factor. The bone chewing proclivities so frequently observed amongst cattle in affected areas provide evidence of this. Bone chewing is known as osteophagia. Bones like carrion may prove highly toxic.

Symptoms in cattle.

The affected animal may be found lying down and unable to rise or it may still be on its feet when noticed ailing. The animal when standing is reluctant to move and walks with a very stiff, often slow, unsteady gait. Salivation is a very frequent symptom in cattle. In many cases there is a profuse flow of saliva which continually runs from the mouth and may be sufficient to wet the ground beneath. In other cases there is frothing at the mouth or a slight but constant dribbling of saliva. The tongue may be paralysed and protrude from the mouth and there may be difficulty in swallowing or inability to do so. Food may be chewed slowly and for long periods without being swallowed. Often the animal is unable to drink, but when drinking is still possible the water is taken slowly and in very small amounts. An animal showing these symptoms soon goes down and thereafter is unable to rise. Death may occur in a few hours to several days according to the severity of the attack. In some of the more chronic cases the animal remains lying down in the normal recumbent position for a long period and there may be no evidence of salivation or inability to swallow. Some animals may even be able to rise to their feet although the gait remains unsteady. Cases of this kind may in some instances recover especially if assisted by appropriate attention and treatment.

Prevention of Toxic Paralysis in Cattle.

The measures described above for the prevention of the disease in sheep which include the control of rabbits, the destruction of carrion and bones and inoculation at the commencement of summer with botulinus toxoid are equally applicable in

the case of cattle. In addition, where there is evidence of bone chewing, mineral licks with a high phosphorus content should be made freely available. Dicalcic lick, which contains 18 per cent. of phosphoric acid, is recommended.

Inoculation of Cattle with Botulinus Toxoid.

The dose of botulinus toxoid for cattle is 10 c.c. and the same technique as described for the inoculation of sheep should be employed when making the injection. The skin of the bovine is considerably thicker, and more difficult to penetrate than that of the sheep, and it may be found desirable to fit the syringe with a stronger needle. A No. 16 veterinary needle may be used to replace the No. 18 needle used for sheep, and will be found satisfactory. During treatment, cattle should be restrained in a bail or crush. The injection may be made at any point beneath the skin, but it is desirable to choose a site where the skin is relatively thin and loosely attached, such as in the front of the shoulder or over the ribs immediately behind the elbow. In long-coated cattle the hair should be clipped before the injection is made.

Treatment of Affected Cattle.

The mortality rate is high and treatment is only worth attempting in the less acute cases. The animal should be sheltered from the elements and provided with a deep bedding of straw. It should be turned night and morning and attention should be given to watering and feeding. Powdered nux vomica should be given at the rate of two drachms night and morning. For convenience of administration the drug should be mixed to a paste with treacle and smeared on the tongue.

In dealing with an outbreak of the disease in cattle, the measures outlined above for the control of an outbreak in sheep should be employed; *i.e.*, the immediate inoculation of the still surviving animals with botulinus toxoid, the removal of carrion and bones beyond their reach and appropriate action with regard to contaminated fodder or water should this be indicated.

Toxic Paralysis in Horses.

Outbreaks of toxic paralysis in horses are not of very frequent occurrence and are always associated with the consumption of contaminated fodder or water. Horses in contrast with sheep and cattle do not develop the condition of depraved appetite which expresses itself as a craving for carrion or bones. Consequently the major predisposing factor is lacking so far as the horse is concerned.

Symptoms in Horses.

In acute cases the affected animal is found lying outstretched on its side making struggling movements with its legs, at first violent but later becoming feeble. It is usually unable to raise its head, but may make frequent unsuccessful attempts to do so. Large patches of perspiration may sometimes be observed on various parts of the body. Consciousness is generally retained, the animal moving its eyes and ears when approached. An animal in this condition does not survive very long, death occurring within 12 or 24 hours. In the less acute cases there appears to be great muscular weakness. The gait is shuffling and unsteady, and when the animal gets down it often lies outstretched on the ground and has great difficulty in rising, or it may be able to rise only when assisted. Cases of this type may sometimes recover with treatment. Salivation and inability to swallow are infrequent symptoms in the horse.

Treatment of Affected Horses.

A high percentage of horses affected by toxic paralysis die. Affected horses should be supported in slings and attention should be given to watering and feeding. Powdered nux vomica in doses of two drachms should be given with treacle night and morning.

Control of Toxic Paralysis in Horses.

When an outbreak of toxic paralysis appears amongst horses the source of the toxin should at once be sought and removed. It is advisable to discontinue the feeding of the chaff or hay which is being used immediately, and to obtain supplies from another source. Such chaff or hay should not again be fed until evidence proving it to be non-toxic has been obtained. The water supply should be examined for the presence of carrion, and if this be discovered it should be detoxicated by the addition of quicklime in the manner previously described.

The prevention of the disease in horses by immunisation with botulinus toxoid has not been widely practised, and the efficacy of this method of control has not been definitely established. Two types—C and D.—of *Cl. botulinum* have been found to exist in this State. Type C only has been cultivated from carrion, but both types have been cultivated from chaff. Botulinus toxoid is prepared from the C type organism and while it will protect an animal against the type C toxin it cannot be relied upon to protect against type D toxin. If, therefore, chaff contaminated with *Cl. botulinum* type D were consumed, previous inoculation with botulinus toxoid would not prevent an outbreak of toxic paralysis. On the other hand, if *Cl. botulinum* type C were present in the chaff, the result of the inoculation would be entirely satisfactory. The type of organism—whether C or D—which most commonly contaminates fodder has not yet been determined, and until this has been done the question as to the efficacy of inoculation with botulinus toxoid must remain open. In view of the irregular and relatively infrequent occurrence of the disease in horses it does not appear to be a matter of pressing importance. Should the demand warrant it, an effective mixed vaccine prepared from both types of the organism could be produced. Should the inoculation of horses be contemplated, a 10 c.c. dose of botulinus toxoid should be injected beneath the skin of the neck.

Diagnosis of toxic paralysis.

The post mortem examination of an animal dead of toxic paralysis furnishes no information concerning the cause of death. The tissues and organs remain unchanged in appearance. It is therefore necessary to consider the history of the mortality which will generally provide evidence of the consumption of toxic material and to study the symptoms which are fairly characteristic. Considered together, the history and symptoms will in most cases place the diagnosis of the disease beyond doubt.

If fodder or water are suspected, samples of these may be forwarded to this department for testing for toxicity. A 2 lb. sample of the fodder or a pint of water will be ample for this purpose.

SUMMARY.

Toxic paralysis which frequently affects cattle and sheep, and to a less extent, horses, results from the consumption of material such as carrion, water polluted by carrion, bones and fodder rendered toxic or poisonous as the result of invasion by a micro-organism known as *Clostridium botulinum*.

The mortality rate is high and treatment of other than mild cases is not worth attempting.

Losses in sheep and cattle are almost wholly confined to the summer months ceasing abruptly with the advent of green feed.

The low nutritive value of the pastures during summer leads to the development of depraved appetite in sheep and cattle which expresses itself in a craving for carrion which is consumed voraciously and may be highly toxic. Carrion eating is known as sarcophagia.

Sarcophagia is not prevented by the administration of mineral licks or supplementary feeding with wheat, oats, chaff or silage.

Rabbits have contributed largely to the occurrence of the disease by eating out the summer pastures and by furnishing an abundance of toxic carrion when intensive measures for their destruction have had to be undertaken.

In cattle, mineral deficiency which expresses itself as osteophagia or bone chewing, appears to be a complicating factor. Bones may be highly toxic. Where bone chewing occurs, dicalcic lick should be made available.

When it is possible to reduce the rabbit population to a minimum by such measures as the netting of properties coupled with an intensive campaign of rabbit destruction at the same time gathering and destroying all carcases, it is possible to effectively control the disease. Such measures are frequently not practicable.

The disease may be prevented in sheep and cattle by inoculation at the commencement of summer with botulinus toxoid which confers upon the animal treated, a strong and lasting immunity.

Outbreaks of toxic paralysis in horses are isolated and of relatively infrequent occurrence. They do not result from carrion eating or bone chewing but from the consumption of contaminated fodder or polluted water. The same cause occasionally operates in the case of sheep and cattle.

Polluted water may be rendered harmless by the addition of quicklime at the rate of 2 lbs. to 40 gallons after the decomposing carcase has been removed.

The efficacy of botulinus toxoid for the prevention of the disease in horses has not been established.

Muresk Agricultural College.

W. Southern, Principal.

It is now fifteen years since Muresk Agricultural College was opened by the Hon. Philip Collier and work was commenced as a branch of the Agricultural Department.

Its location—at Muresk Siding which is on the Great Southern Railway and three miles south of Spencer's Brook—was chosen, as the position makes it possible to carry out most types of agriculture in an area which is one of fairly assured rainfall.

The Avon Valley is good stock country, enabling instruction in various branches of animal husbandry to be given, coupled with practical experience with the animals.

The farm has an area of over 2,000 acres, a portion of which is hilly, and this formation, together with creeks and rock outcrops, tends to make cultivation of these parts difficult. The student is immediately beset with some of the troubles which may confront him on his own farm.

Cereal and fodder crops are grown, particular attention being paid to subterranean clover. Lucerne and maize flourish under irrigation and these crops supply green feed for stock during the summer. Cereal and meadow hay are produced and a considerable quantity of silage is conserved for the dry period. A great deal of fodder is required since, besides horses and sheep, the College possesses a herd of 60 pure bred Guernsey cattle, pure Tamworth and improved Berkshire pigs and large flocks of poultry. The State egg-laying trials are conducted there. In addition to the above activities Muresk has its own orchard, vineyard and vegetable garden.

The class rooms and Laboratory.

As the College is closely associated with the Agricultural Department, it is naturally very convenient to have easy access to the city.

The main aims of the College are:—

1. **To train its students in the science of agriculture, farming practice and in dairy factory work.**

2. **To raise the general standard of efficiency in farming by holding short courses of instruction for farmers.**

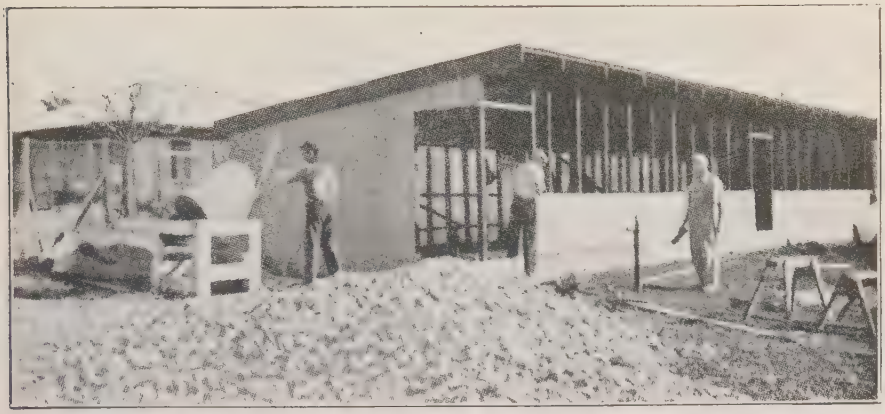
3. **To carry out experimental work.**

4. **To raise the standard of stock in the farming districts by breeding and distributing pure breed cattle, pigs and poultry.**

The College has its own electric light plant and the water supply is obtained from the Goldfields Scheme. The buildings are situated in undulating and well-wooded country. They are mainly of brick, and being of recent origin are naturally up to date, each student having his own room.

Beyond the fact that the subjects taught are, in the main, different from those of a metropolitan residential college, student life at Muresk is similar to that at those schools.

The students have their sports and other recreations, their library, committees and societies. They are encouraged to conduct their own activities as much as possible, so that in later life they may be able to take their part in the civic life of their district. Muresk students must not only become successful farmers; they must ultimately become leaders in their community.



Practical building construction.

Instruction is given in all phases of agriculture and also in building construction, blacksmithing, saddlery and tinsmithing. For the purposes of instruction students are divided into two groups so that half of them are receiving class instruction and the other half practical farm work. At the end of the week the groups change over.

Each week those on outdoor work are divided into sections; some may be on dairy, others on orchard and garden, and so on. A roster is kept so that each student has his fair share of each job. When rush tasks, such as shearing, are in progress, a special roster is prepared so that all students may gain experience in that work.

In all outdoor work each section works under and with a competent instructor, but as each becomes more experienced he is left somewhat to his own resources. It is not uncommon for a student to be seen in charge of a reaper and binder, for example. In this way he gains confidence in his own ability and learns to shoulder responsibility.

The first year of indoor studies may be regarded as a preparatory one. So many of the students, particularly those from the smaller country schools, have not been grounded in subjects which are essential at Muresk simply because they have not had the opportunity. The first year, then, brings them to a standard at which they can appreciate the second and third year work. In effect, the first year is somewhat similar to Junior Certificate standard but the subjects are ones which the majority of youths have had no previous opportunity of studying. Do not gain the impression that the first year has no bearing on agriculture. It most certainly does. It includes English, a general course in agriculture, botany, mensuration, chemistry, physics, physiology, farm book-keeping, algebra and

wool-classing, together with theoretical and practical work in building construction and blacksmithing. All these courses are not hard, but they do give a student a good grounding for the work that is to come.

In the following year the subjects are continued, although some are somewhat altered. Physics gives place to mechanics, algebra and mensuration to easy farm surveying, and physiology to veterinary work. Animal husbandry and farm management are introduced.

A student mowing clover hay.

In the third year some similar changes are made. Mechanics for instance changes to farm engineering, which includes studies of farm implements, tractors, etc., while botany is replaced by plant diseases and bacteriology. A course in dairying is introduced.

From these courses you will see that an Agricultural Diploma holder has a very good grip of agricultural work. He is, in effect, a young man with a thorough knowledge of what he will be called upon to do on a farm. It is not claimed that he is an experienced farmer, but he will attack his work intelligently and enjoy it more. He is also not prone to make the costly blunders which so many men make when they take up agricultural pursuits with little or no previous knowledge.

Older farmers must be aware of serious mistakes that they made when they were inexperienced. These trained young men have another big advantage. They have a good knowledge of the latest trends in agriculture and the training which they have received will encourage them to keep up to date with current developments and knowledge.

The main object of colleges such as Muresk is to turn out young men with that most valuable training. After all, most professions and trades insist on preliminary training or apprenticeship. How can agriculture fail to benefit by a similar idea? You will agree that it is harder to become a successful farmer than a good carpenter or a successful member of most vocations you can think of. If it is harder, then preliminary training is all the more necessary.

The Dairy Science Course which was instituted in 1938 is yet another portion of the curriculum. The course was created in order that butter and cheese factory operatives might be thoroughly trained, and with that object in view a very up-to-date butter and cheese factory has been erected at the college. Thus the students in this course receive not only the theoretical side but also are well fitted to carry out manufacturing.

The factory vacreator.

Provided sufficient educational standard has been previously attained, those who have already had certain factory experience may cover the work in one year. Non-experienced students are required to attend for two years. The subjects studied include Plant and Factory Management, Factory Book-keeping, Dairy Chemistry, Bacteriology, and others.

As yet no reference has been made to the cost of the course. It has been the policy of successive Governments to bring both courses of instruction within the scope of as many as possible and the fees are, therefore, low. Forty-seven pounds per annum covers all fees for tuition, residence, sport and general medical expenses.

If you analyse these fees you will see that they little more than pay for the cost of the excellent accommodation and board which the students enjoy.

For some years the Education Department has offered places in the nearest Government high schools as scholarships for competition among scholars attending country schools, who pass the Junior Certificate examination. Boarding allowances

at the rate of £24 per annum are granted where necessary to parents who are in receipt of an income not exceeding £300 per annum, or alternatively, £50 for each dependent member of the family.

The regulations governing Secondary School Scholarships and "admissions" to the Perth Modern School and other Government high schools permit those who have passed the Junior in their third year to have their scholarship or "admission" renewed for a further two years. These regulations have now been amended to permit scholars who have passed the Junior examination and who wish to take agricultural pursuits to have their scholarship or "admission" renewed at the Muresk Agricultural College.

This concession will also now apply to all scholars attending Government schools who have passed the Junior examination and whose parents can comply with the above conditions regarding income.

College Swimming Carnival.

Scholarships held at Narrogin School of Agriculture are tenable in the first instance for two years. They may be renewed on completion of the course at Narrogin School of Agriculture for those who desire to take the course for the Diploma in Agriculture at the Muresk Agricultural College. Holders of this scholarship may proceed direct to the second year of the diploma course.

The sons of deceased or seriously incapacitated Australian soldiers may receive assistance from the Sir Samuel McCaughey Bequest.

There is so much misunderstanding as to the qualifications necessary before one may be enrolled for the agricultural course that a statement on this matter may be of value There is no entrance examination nor is it necessary for a student to hold the Junior certificate. He must, however, have received enough preliminary education to allow him to benefit by the courses given. Some find that they are sufficiently advanced to be exempted from the first year of study.

A student must be physically fit and also be recommended by his previous teacher or employer.

The Principal will be pleased to supply any information about the College and its activities.

The Last Shilling – if Necessary.

This is a total war, and Australia's must be a total effort if we are to take our share of the Empire's fight for freedom. In this country we are still privileged to grumble about taxes and other annoying things. In England, which is our front line of defence, they are not grumbling about taxes. They are fighting for their very existence, and living in the hell brought by Hitler's bombers. Not only are they fighting a ruthless foe, but they are paying record taxes to finance their fight.

For them there is no respite. Herded underground, they snatch sleep whenever they can. Tired they walk to work from the shelters, often with the roar of aerial battle in their ears and bombs battering the streets.

How different in Australia. Untouched by the scars of war, life goes on normally, sport and holidays are uninterrupted, and all we know of bombers is the tragic daily story we read of our kinsmen's terrible sufferings, of the slaughter of civilians, men, women and children, and of hospitals razed to the ground.

In Australia we are asked to help the Government find some of the colossal sums of money needed to equip our fighting forces so that when they meet the enemy they will meet him on, at least, equal terms.

A million and a half Australians are subscribing to more than 20,000 War Savings Certificates Groups. They have made a substantial contribution to the £16,000,000 raised so far towards the Commonwealth's war commitments. By weekly payments they have been buying one or more of the £1 Certificates. But now that the first cycle of payments is being completed, many of them show an inclination to "call it a day" and to drop out of their groups.

This attitude is unworthy and dangerous. It is unthinkable that Australians should be ready to dismiss so lightly their obligations to themselves and to their own fighting men who have gone overseas in defence of this country.

The Federal Treasurer (Mr. A. W. Fadden) has issued a warning that any slackening of our effort simply cannot be contemplated. He urges subscribers to Savings Groups to continue, and on an increasing scale, the effort which they have begun so well.

"Everybody," he says, "must get down to the job of making every possible shilling available to the Government. The only alternative to the fulfilment of Australia's loan programme is still higher taxation. I don't say that by way of a threat but as a sober statement of fact which reasonable people will accept and act upon."

As in 1914-18, it must be the Last Shilling—if necessary.

Wastage in Export Grapes.

Preliminary Studies with Potassium Metabisulphite.

T. C. Dunne.

Introduction.

While the storage and carriage of Western Australian export grapes on the whole has been satisfactory, there have occurred seasons when the condition of some of the fruit after storage left much to be desired. Unsatisfactory carriage of a good deal of fruit of the 1939 export season led to the decision to conduct preliminary investigations with preservatives during 1940 with a view to control of fungal organisms causing wastage.

Data obtained in South Africa (2) had shown reduction in losses following on the use of formalin and of potassium metabisulphite. Early in the 1940 season some trials were conducted with both these preservatives, using late valensy grapes. Inspection showed more injury and more drying of stems with formalin than with the metabisulphite. In view of these results and by virtue of the fact that South African figures had indicated better control with the metabisulphite, it was decided to carry out investigations with this preservative only.

It is emphasised that the studies were of a preliminary nature and that, in view of the small number of cases used, no significance can be attached to the smaller differences reported. The results have, however, shown much definite benefit in wastage control from the use of the metabisulphite under conditions somewhat different from those obtaining in the South African work, and it is felt that some of the data are worth reporting. The reason for recording all the figures from these tests is that they indicate the varying conditions under which some measure of control has been obtained.

Two other points in connection with the results may be noted at this stage. Firstly, it had been reported privately that injury to berries had occurred when metabisulphite was used under Australian conditions. In the tests reported below injury to berries to an extent not greater than about 3 per cent. was found only in a few instances in which the larger amounts of metabisulphite were used. Secondly, it was found that immediately following removal from cold store, the preservative could be tasted on the berries in cases where it had been mixed with the cork. However, with condensation of moisture on the berries as the temperature rose, the metabisulphite was changed to an inert, tasteless substance. By the time the berries had become dry, therefore, detection of the preservative by taste was impossible.

Evidence obtained in other countries in connection with storage of export grapes, shows that seasonal conditions are definitely connected with the amount of wastage occurring. During the 1939 season unfavourable conditions prevailed and considerable wastage losses were frequent. However, in 1940, when these studies were begun, seasonal conditions were favourable to successful storage as concerns wastage and losses.

Experimental.

The potassium metabisulphite used was obtained in the form of crystals, the maximum dimensions of which ranged from ¼ inch to ½ inch. Portion of this was ground in a small mill and separate portions passed through a sieve, 40 meshes per inch, and through a sieve, 100 meshes per inch. These portions were kept in air-tight containers and used in the experiments as were also some of the original crystals.

Ohanez grapes were used for the work. Although the amounts of preservative quoted are based on cases containing about 30-32 lb. of fruit, the units used were actually only half cases. Unless otherwise stated, the preservative was mixed with the granulated cork used for packing, immediately prior to the fruit being packed. Where preservative was applied to the cases top and bottom, half the total amount was spread on the paper before packing began and the other half spread over the top layer of cork when packing was completed. All packing was done in the field.

Vineyard A—Experiment 1.

During the 1939 season, considerable wastage had occurred in the fruit from this vineyard due to discoloration of the berries with which was associated severe infection with *Penicillium* moulds. Some cork in which the fruit had been packed

had been salvaged, but no attempt was made to kill the mould spores contained therein. Without the knowledge of the writer, this was the cork in which the fruit used in the experiment was packed.

The intention was to study the effect of preservative on grapes packed under what were considered normal conditions. Only two cases of each treatment were taken.

A separation of rotted berries was made on the day after removal from cool store, and the percentage by weight obtained. A second separation was made two days later.

Packed March 29th.

Placed in cool store March 30th.

Separation 1—July 18th.

Separation 2—two days later.

Treatment.	Separation.	Rotted Berries (per cent. by weight).	
		Unit 1.	Unit 2.
Nil—Control	1	42.0	36.1
	2	12.1	13.9
Total	...	54.1	50.0
5 gm. metabisulphite—40-mesh	1	3.1	4.7
	2	.7	4.3
Total	...	3.8	9.0
10 gm. metabisulphite—40-mesh	1	2.4	3.9
	2	.6	1.5
Total	...	3.0	5.4
10 gm. metabisulphite—5 gm. top and bottom—40-mesh	1	9.6	7.6
	2	7.5	1.3
Total	...	17.1	8.9

The control figures showing high wastage illustrate the wastage which may occur from the use of contaminated cork as pointed out by investigations in Victoria some years ago (1). The value of the preservative in controlling wastage is obvious.

Vineyard B.

In 1939 this vineyard suffered mainly from wastage caused by *Botrytis cinerea*.

Experiment 2.

All fruit was sprayed with a suspension of *Botrytis* spores shortly before being packed. A warm dry wind was blowing so that infection of the first few cases may not have been as effective as later on when the interval between spraying and packing was reduced.

Only two cases were used for each treatment. About one month elapsed between collection of data on unit 1 and unit 2 in each treatment.

Packed—29th March, 1940.

Placed in cool store—30th March, 1940.

	Unit 1.	Unit 2.
Separation 1 ...	30th June.	1st August.
2 ...	3 days later.	3 days later.

Treatment (all infected with *Botrytis*).	Separation.	Rotted Berries (per cent. by weight).	
		Unit 1.	Unit 2.
No preservative	1	6 3	15 4
	2	*	8 9
Total	...	...	24.3
5 gm. metabisulphite—40-mesh	1	1.7	5 5
	2	*	2 2
Total	...	...	7.7
10 gm. metabisulphite—40-mesh	1	2.4	2.7
	2	1 8	1.7
Total	...	4.2	4.4
2 gm. metabisulphite—100-mesh	1	3.9	18 2
	2	4.3	9.2
Total	...	8 2	27.4
.5 gm. metabisulphite—100-mesh	1	4 1	3.4
	2	*	1.8
Total	...	...	5.2
10 gm. metabisulphite—100-mesh	1	0.7	3 0
	2	3.9	3.1
Total	...	4 6	6 1
10 gm. metabisulphite—40-mesh—5 gm. top and bottom	1	3 6	2.0
	2	2.1	0.8
Total	...	5.7	2.8
10 gm. metabisulphite crystals—5 gm. top and bottom	1	4 4	18.3
	2	*	4.9
Total	...	...	23.2
No preservatives	1	19.0	40.5
	2	10.6	18.7
Total	...	29.6	59.2

* Figures not obtained.

The data show control of wastage except where only 2 gm. of metabisulphite per case was used and where large crystals were placed at the top and bottom.

Conclusions.

The data obtained from the preliminary investigations reported above confirm the findings of the South African workers concerning the value of potassium metabisulphite in controlling wastage of export grapes during storage. They show, too, that it is effective when used in conjunction with the method of packing prevailing in Western Australia.

It is again emphasised that the small number of units used preclude any significance being attached to the comparatively small differences shown by different treatments with metabisulphite. Some grinding of the potassium metabisulphite usually obtainable does appear to be advantageous

Acknowledgment.

The work reported was carried out with the assistance of the Export Grape Growers' Association of W.A., whose assistance was essential to the investigations. Acknowledgment is also made of the provision of storage facilities by the Westralian Farmers, Ltd.

REFERENCES.

(1) Fish, S.: "A grape export problem—Microfungi on Granulated Cork." Journal Victorian Dept. Agric., 24 : 316-318, 1926.

(2) Reyneke, J. and du Pleissis, S. J.: "Cause and Control of Wastage in Grapes." Farming in South Africa, February, 1939.

Official Milk Records.

G. Slater.

To the majority of dairy farmers in this State the butterfat yield of their cows takes precedence over the quantity of milk obtained, but to those producing for the whole milk trade, the cow which fills the bucket fills the pocket, provided, of course, that the fat content of the milk has a safe margin over the standard of 3.2 per cent.

There are many Ayrshire, Holstein and Friesian cows and their crosses in the South-West with remarkable milk yields, but their owners have been forced to include a number of Channel Island cattle in the herd to raise the butterfat percentage of the bulked milk, which somewhat depreciates the value of the heavy milking-low-fat cow when placed on the market.

It is most unlikely that the average fat content of Australian Illawarra shorthorn, Guernsey or Jersey cows would fall below 3.2 per cent. and it cannot be disputed that rich milk will always find a ready market and may some day command premium prices.

In the meantime, however, the accompanying list of record yields should indicate that there is no necessity to sacrifice quality to quantity as it will be noted that in every case the fat percentage is over the present standard.

Some breeders may remember the high milk yields recorded in 1925 by two Friesian cows owned by Mr. A. L. B. Lefroy, "Lady Fobes Veeman," producing 16,533 lbs. as a junior four-year-old, and "Bolebek Judith," 14,164 lbs. as a senior four-year-old, but in both cases the fat content was below 3.2 per cent. and for that reason, together with the fact that Friesian cows are no longer officially tested, these productions were not included in the table, and it is considered reasonable that any yields exceeding those shown in the table should not be acceptable as records unless the average fat content equals or exceeds 3.2 per cent.

STATE MILK RECORDS—273 DAYS.

Age and Breed.	Name of Cow.	Herd Book No.	Milk.	Test.	Year Recorded.	Butter-fat.	Owner.
			lb.	%		lb.	
Junior 2—							
A.I.S.	Glanavon Golden Girl		11,558	3·60	1937	421·13	D. Bevan & Sons
Guernsey	Koojan Ideal's Daphne	7250	8,821	5·54	1940	489·13	A. W. Padbury
Jersey	Nooka May Queen	41283	7,888	5·22	1934	412·12	S. P. Herbert
Senior 2—							
A.I.S.	Leylands Topsy	17182	11,226	4·15	1936	465·69	D. Bevan & Sons
Guernsey	Yes of Woodlands	2336	9,024	4·28	1928	386·63	A. W. Wilson
Jersey	Colmyn Buttercup	39319	8,734	5·65	1935	493·84	C. H. Ironmonger
Junior 3—							
A.I.S.	Leylands Melba	17170	12,858	4·44	1937	570·46	D. Bevan & Sons
Guernsey	Morden Lady of Koojan	722	10,296	3·78	1924	389·41	A. W. Padbury
Jersey	Girlie of Sarnia	9992	9,038	4·78	1922	432·78	D. Malcolm
Senior 3—							
A.I.S.	Yallah Farm Maggie 2nd	1612	13,233	3·90	1933	508·87	A. W. Padbury
Guernsey	Koojan Bonnie Jean	1272	9,462	5·75	1930	544·50	W. G. Burges.
Jersey	Mokine Empire Lily 7th	11794	10,164	5·69	1926	579·11	T. H. Wilding
Junior 4—							
A.I.S.	Telyarup Duchess	2504	13,792	3·80	1933	522·84	A. E. Grant
Guernsey	Koojan Ace's Jewel 2nd	5661	13,169	5·19	1940	683·45	A. W. Padbury
Jersey	Crantock White Stockings	56955	8,671	3·68	1940	319·54	Mrs. G. H. Burnside
Senior 4—							
A.I.S.	Hope 3rd of the Hill	Vol. 8	13,423	4·44	1930	606·00	W. G. Burges
Guernsey	Koojan Dulcie	1255	10,036	5·71	1929	573·94	A. W. Padbury
Jersey	Banyule Silvermine 55th	25473	10,887	6·07	1933	660·55	Sabina Vale Stud Farm
Mature—							
A.I.S.	Yallah Farm Maggie 2nd	1272	17,541	3·86	1937	677·21	W. G. Burges
Guernsey	Picton Trequean Flirt	747	13,452	5·18	1928	697·98	A. W. Padbury
Jersey	Marinora of Tellaraga	6707	11,509	5·04	1925	584·08	R. H. Rose

Certified Subterranean Clover Seed.

G. R. W. Meadly, Assistant Government Botanist.

Purchasers of Government tested subterranean clover seed are advised to read carefully the information printed on the tags attached to and the slips contained within bags bearing the official seal. These bags may carry a guarantee that they contain seed of a definite strain—either early or mid-season or that they contain seed consisting of at least 98 per cent. pure seeds irrespective of strain. In the second case the factor governing the sealing of the seed is the quantity of impurities such as pebbles, stick fragments, broken, malted or obviously burnt seeds present, and the seed may consist of any strain or mixture of strains. The printing on the tags and slips associated with bags sealed on this basis is always in black type while that of *Strain* certified seed is in red or blue depending on the pure seeds content. The guarantee covered by the sealing is clearly stated on both the label and the slip.

This information is published owing to complaints received from purchasers concerning admixture of strains in what has been referred to as Government certified seed. In every case brought to our notice the seed purchased has been sealed with reference to pure seed content only, the associated tags and slips bearing the following statement:—"The contents of this sack consist of at least 98 per cent. pure seeds, but the attached seal *provides no warranty as to strain.*" The description of the strain in such cases is made by the producer or the merchant.

DEPARTMENT OF AGRICULTURE.

WESTERN AUSTRALIA.

Subterranean Clover Seed.

The contents of this sack consist of at least 98% pure seeds, but the attached seal provides no warranty as to strain.

The Reference Number concerning this seed is P......

This sack was sealed by

.....

Inspector.

Date.....

Specimen of tag.

The complaints received substantiate the desirability of purchasing *strain* certified seed, the slight extra cost being more than offset by the assurance of securing the strain desired.

Another practice adopted by some producers is to guarantee that the seed sold originated from areas passed by an officer of the Department of Agriculture as being suitable for the production of certified seed. The official seed certification scheme, however, entails the inspection of areas during the growing period followed by supervision of gathering and cleaning operations, besides estimating the pure seeds content and taking samples (which are held for reference purposes) of every bag. From a strain certification viewpoint the statement is, to say the least, misleading and carries no official guarantee whatsoever. The real article may be described as Government Certified Early (Dwalganup) or Government Certified mid-season (Mount Barker) subterranean clover seed and if sealed and bearing tags to this effect no supplementary description is necessary.

Citrus Growing in Western Australia.

R. C. OWEN, Horticultural Adviser.

Introduction.

Citrus fruits have been cultivated by man for hundreds of years and although oranges are not mentioned specifically in very early history it is more than probable that the legendary "Golden Apple of Hesperides" was none other than the common garden orange. Here in Western Australia there were at least a few orange trees grown by the early settlers, no doubt from the pips of imported fruits, but there were very little, if any, general plantings until the eighties of last century. There are still trees of these early plantings along the banks of rivers in the older settled areas. Some of the first commercial citrus groves were in the Metropolitan area and as far out as the Guildford, Cannington, Armadale and Hills districts near

Perth. They were all of the seedling orange or what we now term "Common Orange" type for it was not till the end of the last century or the beginning of this one that the navel and late Valencia types made their appearance here.

As the State's population grew the planting of citrus increased and during the last forty years there have been periodic fluctuations, sometimes approaching a mild boom, in citrus plantings, until at the present time orange production ranks second only to apple growing in Western Australia's fresh-fruit growing industries.

The following table shows the areas planted and the yield of the various kinds of citrus during the year.

	1938-39. Area planted. Acres.	Yield Bushels.
Oranges	2,585	322,350
Mandarins	141	17,319
Lemons	422	63,139
Other citrus	36	3,248
Total	3,184	406,056

Citrus trees in the Kelmscott district, and the grower who propagated them from seed over fifty years ago. The tree on the right is a Mandarin tree raised from a seed taken from fruit grown in the Armadale area.

The harvesting period for navels and most other oranges extends from May to November, but the late Valencias which usually mature in October may in a few favoured districts be kept on the trees till the following April so that fresh oranges can be had throughout the year without the necessity for storage. Lemons too are

cropping throughout the year but local mandarins and grapefruit are off the market for several months, and the latter fruit has on occasions been imported from California and Palestine during the last few years.

KINDS AND VARIETIES OF CITRUS.

There are many species belonging to the Citrus family, but only a few are valuable commercially. Those cultivated in this State include:—

1. Oranges *Citrus aurantium.*
2. Mandarins *C. Nobilis.*
3. Lemons *C. limonium.*
4. Pomeloes (including grapefruit) *C. decumana.*
5. Kumquots *C. Japonica.*

In each of these there are many varieties, but of latter years there has been a strong tendency to limit the number of varieties to the few which can be grown commercially and which satisfy the requirements of the consuming public. This is particularly so with oranges, for twenty or thirty years ago any variety, whether Navel, Valencia, Joppa, Queen, Siletta, or even seedling types would command a price, and the seedlings, being more prolific, were probably more profitable than the better class varieties. At the present time, however, any varieties other than navels and late Valencias are classed as "common oranges" and the return to the grower is usually low. In spite of this there are still a number of those out-of-date varieties planted every year and though these might be valuable in marginal areas where a local demand exists, the commercial grower would be wise to plant only those varieties which the public requires.

The following is a brief description of the more popular varieties, but it must be remembered that the qualities vary considerably according to the district in which they are grown, the soil, moisture, and cultural methods employed.

ORANGES.

Washington Navel.—Fruit large, solid and heavy, skin smooth and of fine texture, orange to orange red in colour with the navel marking usually not prominent. Pulp juicy, with little rag, good flavour, seedless. The tree is a strong grower when young, a good and prolific bearer and generally assumes a squat roundish outline when full grown. Foliage dark green in colour.

There are also numerous sub-varieties of navels which have originated as sports from the parent. Included in these are the "Grovelly," "Thompson's Improved," "Navelencia," "Golden Nugget" and "Australian Navel." For the most part these have not the all round good qualities of the Washington and some, particularly the "Australian Navel," are definitely inferior.

Probably the best known sub-variety is *Thomson's Improved.* Fruit somewhat similar in appearance to the Washington. Skin texture very smooth but not necessarily thin, navel scar may be prominent. Pulp crisp but less juicy than the Washington with a tendency to dry out at the stem end. Matures early and is only valuable in some of the early districts.

Valencia Late.—Fruit medium large, roundish oval, skin smooth and moderately thin, yellow orange to orange in colour. Has a tendency to revert to a green colour is left hanging on the trees. Pulp acid till fully ripe, solid, juicy, with only few seeds. Ripens in the spring and in some districts can be left on

the trees till the following April. Old trees have an inclination to bi-annual bearing. Tree vigorous grower with dark green foliage, more upright in growth than the Washington Navel.

MANDARINS.

Trees are generally smaller in growth and foliage than the orange. They are very hardy and bear good crops of small to medium large thin-skinned fruit quite distinct in appearance and flavour.

Emperor.—Fruit medium to large, roundish, irregular and flattened. Skin brittle and somewhat puffy when fully ripe, colour yellow to greenish yellow. Pulp fairly fine, juicy and of good flavour. Tree vigorous and upright with large dark green leaves. Good bearer. With age there is a tendency to produce a mixture of large and small fruits in the one year. Medium early.

Beauty of Glen Retreat.—Fruit medium to large, solid, skin smooth and thin. Colour orange to orange red; skin usually tightly attached to the pulp. Very little rag. Pulp firm, juicy and when ripe is sweet. The fruit colours well before ripening and should not be marketed till the pulp is sweet. Tree vigorous and tends to form a dense head unless thinned out. Very prolific and fruit needs thinning on a heavy crop. Midseason.

Thorny.—One of the best flavoured of all mandarins. Fruit small to medium large according to size of crop and vigour of the tree. Roundish flattened, skin fine, tight and pale yellow in colour. Pulp fine and juicy. Tree moderately vigorous but tends to become dense and bushy. Midseason.

Imperial.—One of the earliest maturing mandarins on the market. Fruit medium in size, roundish flattened, skin fairly smooth and thin, yellow in colour. Pulp moderately fine and juicy. Tree upright and vigorous when young, may be only light cropped in some districts. As it matures its fruit early in the season it needs adequate summer moisture to fill out the fruits before the winter rain.

LEMONS.

Lemons are usually vigorous growers and bear fruit throughout the year. They are less resistant to frosts and should have plenty of summer moisture in order to fill out the fruit during the dry months. The winter crop—often the heaviest—is usually sold in bulk for factory purposes, but the summer and in-between crops should be cured and sold in case lots.

Lisbon.—Fruit medium large in size, long oval shape, skin yellow and moderately smooth, pulp fine grained and juicy; strongly acid and has few seeds. Tree strong and vigorous, prolific, carrying its fruit practically throughout the tree.

Eureka.—Fruit medium size, good quality, skin bright yellow, smooth and thin, pulp juicy and acid. Tree hardy and prolific, but not so dense in foliage. Much of the fruit is carried on the ends of long growths and is not so well protected from sunburn. Practically thornless.

Villa Franca.—Fruit medium to large, oblong and slightly pointed at blossom end, pulp juicy and nearly seedless. Skin bright yellow and thin. Tree hardy and prolific, almost thornless, foliage strong and abundant.

GRAPEFRUIT.

Grapefruit.—Is a sub-species of the pomelo and so called because of the tendency to set its fruit in bunches. The fruit are fairly large, 3-5 inches in diameter, of roundish flattened shape, pale lemon yellow in

colour. The pulp is regarded as being very wholesome and refreshing, and possessing tonic properties. The fruit may be eaten fresh and has become popular as a breakfast delicacy. It may be used for making fresh-fruit drinks and also for marmalade. In the latter respect it is replacing the Seville orange.

There are several varieties of grapefruit including Triumph, Fosters and Marsh's seedless. The last-named is by far the most widely planted here and has proved itself a strong, vigorous grower, and very prolific. The fruit is carried throughout the tree and usually the best quality fruits are those borne on the inside. Matures from May onwards and in selected districts may be carried on the trees till Christmas time.

KUMQUOTS.

Kumquots are a dwarf species of citrus and a native of Japan. They are very hardy and prolific. Tree is very bushy with small, yellowish green leaves. Very ornamental. Fruit is small—about the size of a small apricot. There are two varieties grown—a round and an oval-shaped fruit. The round type is only suitable for marmalade, but the oval type is excellent for preserving. The demand for this class of fruit is only limited.

Soil.

The recognised citrus growing districts in the West, range from Mooliabeenie-Bindoon and Chittering in the hills and foothills some forty miles north of Perth, Kalamunda and other centres in the Darling Range eastward, through Gosnells, Armadale, Serpentine, Harvey to Boyanup, Donnybrook and Capel on the coastal plain and over a hundred miles south of Perth. Apart from the three first mentioned districts where citrus culture is the main activity in the fruit-growing pursuit, citriculture is often combined with the growing of stone-fruits and in some places with apples.

Citrus fruits generally are indigenous to those tropical and subtropical regions of Asia and the islands of the Pacific where the climate is equitable and the rainfall is sufficient. The trees prefer a deep well drained loamy soil and they need adequate moisture throughout the year. They will not thrive in shallow undrained soils nor in districts where frosts are frequent and severe. In many of the inland districts of America, Africa and Palestine, and also in parts of the Eastern States of Australia, oranges and other members of the citrus group are now grown in areas that were formerly little better than desert regions. The moisture problem has been overcome by large irrigation schemes and the frost hazard controlled by artificial heating. In Western Australia however, the market requirements do not as yet warrant planting in districts other than those naturally suited to the trees or where local irrigation plants can be cheaply installed.

Undoubtedly the most important environmental factors in citriculture are soil, moisture and temperature, and while the latter two can be controlled within limits by artificial means, the suitable soil is often the limiting factor to the areas planted. In this State oranges and lemons have been planted over a wide range of soil types and in many adverse soil conditions and although the trees have shown their adaptability by making good growth over a number of years, it is only those planted on the deep, well drained and well manured soils of the medium to lighter types, that have maintained their growth, vigor and productivity for thirty years and more. Contrary to general beliefs the citrus trees are not naturally of a shallow rooting habit, for although the finer feeding roots are mostly on the surface regions the heavier roots range outwards and downwards to a considerable depth. They will not, however, penetrate heavy clay subsoil or compacted hardpans nor will they

persist below the permanent water table. Heavy soils do not as a rule produce large or long lived trees but the fruit is often of excellent quality. The lighter soils may not be naturally so rich in plant foods, but they allow of extensive root development and any lack of fertility can be corrected by the application of manures and organic matter. Good deep loams and lighter soils also allow of better and quicker drainage and so approach the ideal for citrus growing.

A contrast in rooting systems. Stumps of orange trees grown on the bank of the river at Gosnells. The vigorous rooted stump on the left was grown on deep alluvial soil with the permanent water table over eight feet down. The stump on the right was grown on the same class of soil, but was not so well drained.

Prospective growers who contemplate establishing a citrus orchard should choose a district which has proved satisfactory for the growth of that kind of fruit, or a district which has a rainfall of at least 30-35 inches and a fairly mild winter temperature. If a sufficient permanent supply of fresh water is available the natural rainfall figures are not important. The choice of the actual site must be governed not only by the suitable soil but also by the natural protection afforded from the prevailing winds and severe frosts. Although the surface soil will give an indication do not rely solely on appearances but by means of a soil auger, test the soil and subsoil to a depth of four to five feet. Avoid those areas where a heavy clay subsoil comes near the surface, also shallow soils overlying cemented hardpan or rock. Deep sands and gravelly washes are also objectionable because they lack fertility and have a poor water holding capacity. The surface soil may be sandy provided the subsoil is of a heavier nature, for a light surface soil facilitates tillage, allows free entry of water and does not cake after irrigation.

When preparing the ground for the citrus orchard great care is necessary to see that all large roots are removed to the depth of several feet; this is particularly important if the original timber is marri, blackbutt or other trees which favour the growth of that root-rotting fungus *Armellaria melia* which is so fatal to citrus.

After clearing, the land should be broken up to a depth of ten to twelve inches, and provided the soil is suitable there is not much object in going deeper. Any areas showing hardpan may be broken up by means of a subsoil plough or in extreme cases be explosives. If at all possible it is desirable to have the land cleared for at least a year prior to the planting so that the numerous small roots will have rotted away before the young trees are planted. The extra time and care taken in thoroughly preparing the land is by no means wasted for citrus respond to good treatment and the resultant strong and even growth throughout the plantation will make it well worth while.

DRAINAGE.

Adequate drainage is very important in citrus growing and although many orchards in this State have sufficient natural drainage there are others which need more and deeper drains. All citrus trees dislike cold and waterlogged soils and even if the actual surface soil does not suffer from excess water and become waterlogged there is every possibility that the water level will rise close to the surface during the rainy season. There may be only a small section of the orchard affected, perhaps an outcrop of rock or impervious soil prevents the free passage of water, thus causing a boggy patch, or again there may be a saucer-like depression which collects seepage. The only way to ascertain the need for putting in drains is by actual observation, and if test holes, three to four feet deep are dug in likely places throughout the orchard any serious rise in the water table can be noted during the wet season. A temporary rise after excessive rainfall is not serious but if the water remains within three feet of the surface for more than a week, that part of the orchard would be benefited by more or deeper drains. Where there is plenty of depth of soil drains may be five feet deep; in most cases, however, 3 feet 6 inches to 4 feet deep drains are sufficient provided they are not too far apart. For the sake of economy arrange the drains to effect the maximum drainage with the minimum length; allow sufficient fall to provide a free flow of water but avoid too much slope if there is a danger of scouring.

To facilitate cultivation and also to prevent the soil from drying out during the summer all drains in the orchard should be covered in. Burnt clay or cement concrete tile drain-pipes, although expensive, are easy to lay and give good service; where suitable rock is available a good stone drain can be put in at relatively low cost. Box drains made of timber, when constructed in a workmanlike manner, will give from thirty to forty years of service, but the makeshift drain of saplings, blackboys or temporary materials, generally give trouble and are often only a waste of time and labour.

PLANTING.

After the orchard site is cleared, broken up and drained it is ready to lay out in preparation for planting the trees. The usual systems of lay-out are:—

(1) *The Square System* where the trees in the rows are the same distance apart as the rows themselves. This allows of two ways of cultivation at right angles to each other, it is easy to set out and is suitable for all but the steeper slopes.

(2) *The Septuple System* where trees are equidistant from each other and in groups of seven-six trees forming a hexagon with one tree in the centre. This system allows of three ways of cultivation at angles of 60° to each other, but in no case is the width of cultivation as wide as the distance the trees are apart. The septuple lay out

is very suitable for planting hillsides where it may avoid working straight up and down the slope. With the same distance between the trees it allows 15 per cent. more trees to the acre than does the square system but of course each tree has approximately that much less feeding space at its disposal. Contour planting is now being practised in other parts of the world in an endeavour to avoid soil erosion.

There has been some controversy about the most suitable distance to allow between trees when planting citrus; some favour twenty feet whilst others advocate distances up to 30 feet. The writer considers that twenty feet between trees is suitable for most mandarins and other varieties having upright or dwarf habits of growth, but 24 feet or more is necessary for the larger growing orange and lemon trees. Where the soil is good and the water supply ample all the space is needed to accommodate the top growth, whereas if the soil is poor or the moisture limited the extra distance provides a bigger store of plant food moisture.

The best time for planting citrus trees is when the weather is moderately cool but not when the soil is cold and wet. If the trees are available, autumn planting during April and early May is suitable in frost-free districts; where the trees are not procurable till later or in regions where winter frosts occur, the spring planting in August and early September gives the best results. Prior to planting, remove any dead or injured roots by severing with a sharp knife or secateurs, and have the holes fertilised and prepared to receive the tree. Mix any manure well into the soil and below the root area, and so avoid the possibility of putting the roots in direct contact with artificial manures. Where chemical manures have been applied in close contact with the roots, it is no uncommon thing for the trees to remain dormant for months, and though some may eventually grow, many gradually die out. When setting the tree, spread the roots well out and press the soil closely about them. Do not plant too deeply—deep planting does not mean a deep rooting tree—it may lead to the loss of the tree through *Collar-rot* or *Gummosis* of the trunk. If the trees are set in the ground at the same depth as they originally stood in the nursery, or even slightly shallower, there should be no trouble.

After planting it is a good idea to tie the tree to a stake and hold it firm against winds, and also if the trunk is wrapped with straw, paper or bagging, it will protect it from the direct rays of the sun until such time as the tree provides sufficient shade for itself.

Through the summer the main concern is to control weed-growth and conserve soil moisture. Keep the surface soil near the tree in a good tilth but do not cultivate deep enough to disturb the roots or to dry out the soil at length.

SELECTION OF TREES.

When planting citrus trees due care should be taken to see that none but healthy and vigorous plants are selected. This is a matter of extreme importance as if the trees are unhealthy or weakly in constitution they are unlikely to give the grower satisfaction.

Nowadays citrus are all "worked" or budded trees and as the propagation of these is a specialised trade, it is in most cases better to leave it to the experienced nurseryman. He can usually be relied upon to supply good healthy trees on suitable stocks, but to give him a chance to supply your requirements and to avoid possible disappointment, it is always advisable to place your order some months in advance of planting time.

Of late years there has been a move towards standardisation of citrus types and by "Bud Selection" much is being accomplished. "Bud Selection" means that the buds from which the trees were propagated were taken from parent trees selected for bearing good regular crops of fruit, true to type, and free from hereditary weakness. But selected trees may vary under different environmental conditions, but where conditions are alike they produce groves of even trees bearing regular type fruits. It is too much to expect even bud selected trees grown under unsuitable conditions to produce fruit of equal quality as the same trees grown under congenial conditions.

Apart from the selection of buds much can be done by the nurseryman in culling out unsuitable root stocks and only using those which are strong and vigorous. The rough lemon or citronelle rootstock is favoured by most nurserymen as it is a vigorous grower and produces a good sized tree in less time than most other stocks. It is quite satisfactory under a wide range of soil conditions but some claim that the sweet orange stock is preferable for, although slower in starting, it eventually produces a large and long lived tree.

If the old sweet orange seedlings still growing in many parts of the State are any indication the sweet orange stock is very suitable for the majority of our citrus areas.

Other stocks sometimes used are the sour orange or Seville, which are said to resist collar-rot or gummosis even under wet conditions. They are strong rooting, but must have a deep and rich soil.

Citrus trifoliata is also used and is supposed to have a dwarfing effect on the tree. The few older trees I have seen on this stock are rather unsatisfactory.

For general plantings, trees carrying one years growth from the bud are suitable, although older trees may be used provided they have been suitably "balled" to protect them during transport from the nursery. They are, of course, more expensive than the younger trees. When replacing trees in established orchards it is quite a good idea to purchase the trees one or two years in advance and establish them in a suitable nursery on the place. With careful attention they will make good growth and at a suitable time can be transplanted without suffering any ill effects, and will then have a better chance of competing with the older established trees around them. With care, even old trees can be transplanted, for the writer has successfully shifted trees over thirty years of age and established them in positions among full bearing trees. In this case, however, it was necessary to cut the top growth back in proportion to the roots removed in transplanting.

CULTIVATION.

General cultivation methods in citrus growing are very similar to those carried out in any other orchard, the main objects being to maintain the soil humus by growing weeds or special green crops during the winter or wet season and ploughing them in so that the green material is well rotted before the dry season sets in, and to conserve the moisture and keep down weeds during the dry months of the year. It is much easier to maintain or even build up the humus content of the soil right from the start than to replace the organic matter after the soils have become worked out. As the trees increase in size there is less space in which to grow the green crop, and also the evergreen trees cause a dense shade and limit the growth of the crop during the short days of winter.

Commence the building-up process from the time the orchard is planted, and when the trees are full grown there will be ample reserves of organic matter, so

the maintenance will be much easier. Green crops of the legume family—beans, peas, lupins, tares, etc., not only maintain the humus content but also greatly augment the nitrogen supply of the soil and so make it possible to reduce the quantity of expensive nitrogenous manures used. New Zealand blue lupins or tick beans when planted early in the season make excellent green manure crops; they are easy to plough in and readily decompose in the soil. Whatever crop is grown, even if only natural weed growth, the secret of success is to plough it in early enough so that it decays and allows the cultivation to be completed before the dry weather sets in.

Avoid excessive summer cultivation when the soil is dry, because not only is it unnecessary from the point of view of moisture conservation, but it tends to break up the soil particles and cause loss of humus. This leads to the soil becoming "snuffy" when it will not absorb water readily, and is likely to be lost by erosion. The dust menace too is considerable, and this in its turn will choke the leaf pores and also favour the breeding of citrus red scale.

MANURING OF CITRUS.

Citrus trees when once established will go on producing fruit for years without any special manurial treatment, but eventually they become unthrifty or fail completely. It will then take several years at least of heavy manuring to restore them to a good healthy condition again, so it is far better to keep the trees going steadily by the regular application of suitable manures. It is generally recognised that all fruit trees need an all-round manure containing phosphates, nitrogen and potash, but the proportion of each of these elements and the amount used is largely dependent on the age and condition of the tree and the natural richness of the soil. Most of our soils are deficient in one or more of these necessary constituents but in the absence of experimental data it is impossible to recommend any mixture or fixed quantity of fertiliser for all soils. The whole problem is a question of balance between the necessary plant food elements, and while analysts may determine the chemical constituents of a tree and its crop we cannot guarantee that by placing these constituents in the soil the plants will receive them, for chemical changes take place in the soil and may render some of the substances insoluble or at least unavailable to the plant.

A fertiliser mixture that has given good results and maintained trees in growth and cropping is a mixture of superphosphate, sulphate of ammonia and sulphate of potash roughly in the proportion of 2.2.1. and giving an analysis of P_2O_5 9 per cent., N 8 per cent. and K_2O 10 per cent. Some growers prefer to use bonedust or blood and bone, but these are not balanced and should be fortified with soluble phosphate and potash.

If good crops of leguminous plants have been regularly ploughed in for a number of years the proportion of nitrogen in the mixture can safely be reduced otherwise the trees tend to become too rank and produce a soft and insipid fruit, which does not keep well.

The quantity of fertiliser to apply is largely dependent on the size of the trees but dressings of over 10 cwt. per acre should seldom be necessary, and an average of 4 to 6 lbs. per tree is often adequate. When purchasing manures it is far better to spend say, £10 on a ton of well balanced manure than the same amount on two or more tons of manure containing say only phosphates, unless there is definite evidence to show that only phosphates are required. In other States it is often advocated that sulphate of ammonia or nitrate of soda should be applied at the annual rate of one pound per tree for every year of the tree's age

up to twelve years. That is a tree of more than twelve years of age would receive twelve pounds of concentrated nitrogenous manure every year. In this State where we experience long dry summers and heavy rains during the ripening and maturity period of our orange crops, that amount of nitrogen would be out of all proportion.

Ploughing in a green manure crop of peas and oats. Crops like this turned in regularly every year will do much to maintain the fertility of the soil.

Lemon trees which produce heavy crops of fruit and which must be kept growing strongly, will stand heavier nitrogenous manures than oranges and other fruits.

The time for applying manures to citrus is still controversial but as the trees are evergreen and growth is intermittent throughout the year there is some evidence that to divide the annual amount into two or three dressings, say, early Autumn, Spring and Summer is beneficial.

This summer dressing can only be applied where irrigation is possible for it would be unwise to apply readily soluble manures when the trees are stressed for want of water.

The phosphate and potash manures, because they do not readily wash out of the soil, may be safely applied in one dressing and placed as deeply as possible in the soil. If, however, the soil is rich in iron, there is a danger of the soluble phosphate becoming changed to insoluble iron phosphate and thus lost to the plant. In that case the phosphate could be applied as acid soluble basic phosphate which though only slowly available to the plant would last in the soil for a long time. Readily soluble nitrogenous manures may be applied as a top dressing during the Spring or Autumn or with the irrigation waters in the Summer.

IRRIGATION.

As mentioned previously, citrus trees need an ample supply of water, especially through the hot summer, and as 80 per cent. of our normal rainfall occurs between the months of May to October the remaining six months of hot dry weather puts a severe test on water reserves in the soil. There are very few orchards here which can adequately maintain full bearing citrus trees throughout the year without irrigation,

but unfortunately there are many places which through lack of sufficient water supply are denied this necessary irrigation and consequently the trees never have a chance to produce their quota of good quality fruit.

It is surprising just how much drought an orange tree will endure and still mature fruit of a sort, but that fruit is usually small, of poor texture and juice content and effected by drought crinkle. Another effect of drought is out-of-season fruit caused by the trees flowering profusely after the flush of sap caused by Autumn rains.

At present there are no big acreages of citrus in our recognised irrigation areas and practically all the orchard irrigation is carried out from comparatively small private schemes. A few fortunate growers situated on permanent water courses in the hills can gravitate the water on to their orchards with very little cost, but the majority have to instal plants commensurate with the size of their orchards, or in accordance with their available water supply. These supplies are drawn from the local rivers, creeks, soaks and wells and there are various systems of applying the water to the soil.

Where the supply is limited and the orchard is not graded the most economical method for even distribution is through pipes and sprinklers. This method is more costly in power and the initial installation of piping and also necessitates some form of cultivation after each watering, but there is actually less work involved, and there is no soil washing. This method is becoming increasingly popular with citrus orchardists. Some growers use movable sprinklers connected by hoses to the fixed supply pipe, others make use of light piping made from galvanised sheet metal with the sprinklers fixed directly into the pipes. These pipes can be easily shifted about and coupled up again so that when one land has been watered the pipes are set up in another place, and so on until the whole orchard has been covered. Usually the sprinklers are left running for 1½ to 2 hours in the one place and this approximates 1½ to 2 inches of water.

Where the water supply is adequate and the land is better graded the method of open furrow irrigation can be used. The water is caused to flow down one or more open furrows between the trees, the number of furrows depending on the flow of water and the type of soil concerned. Furrow irrigation is more difficult to control unless the grade is even and the subsoil uniform in texture. There is always a tendency for some trees to be over-watered while others might not receive sufficient, if drainage is not sufficient seepage may occur and cause waterlogging and consequent damage to the trees.

For the best results use comparatively short furrow leads—not more than five chains—and use the maximum volume of water without causing scouring. The practice of watering citrus by flooding, where the butts of the trees are inundated or kept wet for any length of time should be strongly condemned, for it will eventually lead to loss or damage to the trees through collar-rot and brown rot gummosis

Whatever system of water reticulation is used it is preferable to give a few good waterings at long intervals rather than frequent waterings of short duration. Do not commence irrigation before it is necessary because heavy applications early in the season are likely to chill the ground and may check the activity of the roots and the soil bacteria.

Within a day or two after irrigation the soil should be lightly cultivated to loosen up the surface and prevent any weeds from growing.

PRUNING.

Pruning of citrus is not classed as essential by many growers and while it is true that young trees need very little in the way of pruning excepting to keep the main framework open the older trees are in most cases benefited by some form of pruning to remove the dead and dying fruit wood.

Valencias which have a more free and open type of growth need only occasional cutting to keep the branches off the ground and to remove spent fruiting wood. Navels, however, rapidly become dense and unthrifty if pruning is neglected for long especially as the trees advance in years. The nature of a Navel tree is to expand by throwing out successive layers of fruiting wood and as the older wood outlives its usefulness it slowly dies and is succeeded by new growth. As this new growth extends it gradually shuts out the light and the fruiting wood inside the tree is forced out of existence. The dead wood in itself is harmful because it scratches and blemishes the fruit and also forms a breeding ground for harmful fungous diseases, but the worn out wood is just as harmful because without helping in the necessary metabolism of the plant it is still living and in effect is robbing other parts of essential plant food. This worn out wood should be removed by pruning as soon as it becomes weakly and in doing so the dead wood of the future will be dispensed with.

The outer surface of the tree should be kept sufficiently open to allow light and air to circulate but not too open to allow the direct rays of the sun to penetrate and scald the main branches. The inside fruiting wood may also be thinned to allow the remainder plenty of room to bloom and crop. If the work is done regularly the tree can be kept strong and healthy and that tendency for over-blooming followed by poor setting—usually a sign of a weakened condition—can be overcome.

Mandarin trees, too, become very dense and bushy if not pruned. This leads to the tree becoming weakly and bearing large crops of small fruits poor in quality.

The important thing is to anticipate that too-heavy crop and reduce it by judiciously thinning out the fruiting wood. This will maintain a better balance between fruit and wood growth and so keeps the tree in a healthy and profitable state.

Lemon trees respond readily to good pruning but if neglected they soon deteriorate. To fully realise this it is only necessary to crawl under one—this in itself is a feat requiring skill and determination—and take a look from the inside. There will be seen a dense mass of dead and dying wood interlaced by watershoots and suckers struggling to reach the light. Finally if they ever reach the outside they blossom and carry a bunch of fruit which sways about and becomes hopelessly blemished before it is even half grown.

The lower branches, too, when tangled on the ground interfere with harvesting and cultivation; in the winter they keep the trunk and main limbs so damp that the health of the tree is endangered.

The lemon tree can be kept fairly open, and by regular pruning the fruiting wood should be renewed as soon as it shows signs of flagging.

Even young and vigorous trees can be benefited by using secateurs. Those long rank shoots should be shortened back to stimulate the growth of finer lateral fruiting wood which carries the better quality fruit. By carefully observing the time and effect of this style of pruning from one season to another it is possible to stimulate the production of the summer crop of fruit. In most districts it

takes ten to twelve months from the time of pruning to force the new laterals, carry the blossom and mature the fruit, so that if the pruning is done in the early summer months the resulting crop should be ready for harvesting during the summer of the following year. In an endeavour to stimulate the summer crop the grower must be prepared to sacrifice a portion of the winter crop which will have already set. Control of soil moisture by irrigation is essential to bring a heavy summer crop of lemons to size and maturity.

Healthy navel orange trees grown on sandy loam in the Pickering Brook district. The trees in the background are thirty-eight years old and have occupied their full planting distance so there is now very little room for cultivation. The trees in the foreground are one-year-olds replanted in the place of old lemon trees.

It is better to prune lightly every year or two rather than to wait till the tree is a mass of unthrifty wood before cutting it heavily in an endeavour to restore its vigour and fruitfulness.

HARVESTING.

Harvesting the crop is quite as important and needs just as much care and attention as any of the other cultural items. Some growers who are most particular in giving the trees every attention to produce excellent fruit, spoil the effect and actually lose money by careless methods of picking and packing. Oranges, and in fact all citrus fruits, have their juicy pulp protected by a more or less tough skin and can be kept for a considerable time after they are normally ripe provided that skin is not damaged. Once the surface is broken the spores of decay organisms gain access and the fruit rapidly breaks down.

When fresh picked the cells of the skin and rind are full of moisture and are easily bruised or scratched, so great care should be exercised during picking operations. Actually the fruit should not be picked but cut from the trees with a pair of blunt-nosed snips. During the work the operator should wear soft gloves

or at least keep his finger nails closely trimmed to avoid damage to the fruit. Picking bags which are strapped to the shoulders are most convenient receptacles for holding the fruit before it is transferred to the boxes, because they leave both hands free for work. Gently grasp the fruit with the left hand and with the snips in the right hand cut the stem an inch or so back from the fruit, then with a second cut neatly sever the short piece of stem close to the button. By making the two separate cuts the stem which would otherwise die back is removed from the tree, also the cut close to the fruit can be made closer and cleaner with less risk of damage. Fruit should be placed—not dropped—into the picking bag. Do not over-fill the bag as this tends to crush the skin, especially if the picker is working from a ladder. Carefully transfer from the bag to the packing boxes. So far as possible avoid picking the fruit when wet; if this is not practicable then as soon as convenient afterwards spread the fruit out on a bench in the shed to dry. Fruit intended for long transport or for storage is better if not packed immediately, but left for some days in a cool, dry place so that the excess moisture in the skin can dry out. This causes a toughening of the rind and makes the skin less susceptible to injury.

Oranges in commercial quantities do not keep for long periods in store, and it is usual to let them remain on the trees till convenient to market. In districts where the fruit matures early the grower should avail himself of the higher prices ruling to dispose of his crop—within the limits of the market—before the later districts commence harvesting. In this way the loss through windfalls will be appreciably less and the mid-season gluts can in some measure be avoided. The grower in the late maturing districts, however, is faced with a different problem. Most of his Navel crop is ripe during the months of plentiful supplies and he has the choice of marketing the bulk of the crop at comparatively low prices or risking heavy losses by windfalls and breakdowns in an endeavour to keep some of the fruit for the higher prices ruling towards the close of the season. The decision rests with the grower, but if he chooses to keep his Navel oranges on the tree for months after they mature, then it is only natural to expect a proportion of windfalls and decayed fruit.

LEMON HARVESTING AND CURING.

Oranges and mandarins and to a lesser extent grapefruit are marketed within a comparatively short time of picking, but lemons, apart from winter fruits for factory purposes, are better if cured before being sent to market. In this case the fruit should be picked before it is fully coloured or ripe. Pick to size rather than to colour for the market requires a moderately small lemon of about 2¼ inches diameter, and if allowed to fully develop some of the fruit would be oversize and course in texture. Green fruit may be picked when it attains 2½ inch diameter, for in the process of curing it will shrink considerably. Most of the crop will be picked just as it is turning in colour from green to yellow, and this is the ideal stage for curing. As with other fruit careful picking and handling is essential, the main cause of fruit rotting and becoming mouldy in the curing room can be traced to bruises and scratches received in picking.

Grade the lemons before curing and cull out all misshapen, blemished or tree-ripe fruits, for they will not warrant curing, and only occupy valuable space in the chamber. If the market warrants it these culls can be packed fresh or disposed of to the factory for processing either for peel, juice or essential oil.

The curing process is really only a slow reduction in the moisture content of the skin accompanied by a change in colour and in the general texture of the whole fruit. During the process the skins become tougher, but more fine and

thin and assume a soft leathery feel, the rag or white pithy substance practically disappears. There will be some loss in size through shrinkage and this varies according to the type and stage of maturity of the original fruit. There is very little, if any, loss in the actual juice content and the proportion of juice to the total weight of fruit is greatly increased.

The secret of successful lemon curing is to carefully pick the fruit before it is too mature and then place it in a room or container where the moisture reduction can be controlled. If the moisture is lost too rapidly, or too much is lost, the fruit will become shrivelled and will look unattractive; if the rate of curing is too slow there will be a bigger chance of losing a proportion through mould and breakdown.

The curing room must not be draughty and should be kept at a moderately even temperature. Once it was considered that an underground room or cellar was essential for lemon curing, and although very suitable it has no advantage over an ordinary room where the temperature can be kept regulated and the ventilation controlled.

Some growers place the lemons in clean sand or sawdust and either of these give very good results, but both entail extra handling and cleaning. A method which is very much simpler and which also gives excellent results, is to place the fruit loosely in boxes, stack them in the curing room and cover entirely with a light tarpaulin or sacking. A little experience will indicate just the amount of covering necessary and inspections can readily be made to see when the fruit is cured. The usual time for complete curing is from three to six weeks, varying according to the temperature and the state of maturity of the fruit. Once cured the fruit can be marketed immediately, or if the price does not warrant sale, can be kept in the room for weeks or even months without serious deterioration. Lemons picked during the drier months of the year can be cured with very little trouble, but during the cold damp months of mid-winter when the skins are soft and full of moisture it is practically impossible to get consistently good results. Probably artificial heating and air conditioning would solve the problem.

USE OF ETHYLENE GAS.

Citrus fruits showing green colour, if kept for a few days in an atmosphere charged with ethylene gas will rapidly change colour and take on the appearance of normal ripe fruit. This treatment does nothing more than colour the rind and leaves the pulp and juice content unchanged. It is valuable for re-colouring ripe Valencias which have reverted to a green colour through being left on the tees, and is also used for prematurely colouring lemons and navel oranges. Lemons, of course, are normally sold for their juice, which is rich in citric acid, and as this acid is present even in immature fruit, the gas-treated fruit does not differ much from the normal lemon.

Oranges, however, are expected to contain a certain proportion of sugars and to be reasonably sweet to the taste, but immature oranges which have been artifically coloured by gas treatment are often lacking in this respect. The purchaser relying on colour as a sign of sweetness, is often deceived into buying fruit which is not true to nature's label.

There are arguments for and against this gas treatment for colouring immature oranges, but so long as the public are willing to pay higher prices for well coloured oranges early in the season, the enterprising grower will do his best to supply that need. Growers, however, would do well to remember that the consumer once deceived may not be inclined to buy again till late in the season. This temporary loss of public buying would have serious repercussions on the market price.

PACKING.

By far the greater part of Western Australia's citrus crops are consumed within the State, and the small export trade is practically confined to Java, Singapore and Columbo. For local trade the fruit is usually packed in the Australian dump case, the three-quarter dump case, or the three-quarter bushel flat case. For export the standard citrus case holds 1 1/3 bushels but a half citrus box holding 2/3 bushel may be used for lemons.

Before packing the fruit should be graded for size and quality, and firmly packed in the cases, using only those packs which will bring the top layer of fruit level with the top of the case without undue squeezing. The number of fruit in the case should be legibly marked on the outside so that the prospective buyer can see it at a glance and mentally work out the cost of the fruit per dozen.

DISEASE AND PESTS.

As with growing other kinds of fruit or in producing any other type of agricultural commodity there are a number of pests and diseases to contend with in citrus growing. Every year these diseases take their toll and a proportion of the crop is lost entirely or is reduced in value. Practically all pests and diseases have their particular remedy and the careful grower who takes due precautions to combat these pests may find some consolation in the fact that if plant diseases were unknown the production figures would rapidly increase to such an extent that unless new markets were found the monetary returns would be very low indeed.

It is not possible in this article to give details of the diseases which affect citrus trees and fruit but most of these diseases and their control are dealt with in various bulletins and "Journal" articles of this department. These can be had free of charge on application. Growers are advised that if a disease or pest appears concerning which they have no knowledge, specimens should be forwarded together with full particulars to the Department of Agriculture, or to their nearest District Officer. If this is done, correct control measures will be prescribed and possibly the growers will be saved much unnecessary labour and expense.

BUDDING AND GRAFTING.

It has been mentioned earlier in this article that in this State there are still many citrus trees of the older seedling types and varieties of low commercial value. These trees in many instances do not pay for their upkeep and should be dealt with accordingly. Where the tree is unhealthy or unthrifty through disease of the roots and trunk it is a waste of time to do anything else than grub it out and if desirous, replant with a healthy tree of suitable variety. If the tree is still healthy and vigorous it may be worked over to a more profitable variety, and will in a few years time produce good crops of fruit for which there will be a market demand. Apart from the semi dwarf varieties of mandarin trees which may not form good stocks for more vigorous kinds, all commercial citrus varieties can be successfully grafted or budded one on the other. Citrus wood, because it does not callous readily, is not the easiest to graft, but provided the work is done carefully in the early spring—August and September—there should be fair prospects of success. Large trees must be cut back for reworking and if cleft grafted scions are inserted in the cut limbs there is a chance that they will grow. If these scions fail, the cut limbs will send out numerous new shoots which will be fit to bud the following season. When cutting back a tree for reworking always leave a few limbs intact to provide shade for the trunk and main arms. A coat of limewash painted or sprayed on any exposed limbs will do much to protect the bark from sun scald. One of the greatest difficulties in

budding or grafting citrus is to procure suitable scions and budding wood. It is desirable to select scions from mature trees which have proved themselves heavy and regular bearers of good quality fruit but these trees very often only produce fine fruiting wood unsuitable for grafting or budding. When a grower anticipates reworking a number of old trees it is a good idea to prune back a portion at least of the desired bud-wood tree so that it will make strong enough growth to provide scions in time for the contemplated budding or grafting operation.

Budding into vigorous young shoots which arise after the old tree has been headed back, is the most reliable method of reworking citrus. Use the ordinary shield method of cutting the bud and insert in the stock by making a "T" or inverted "T" cut. The bud should be cut from one year old round wood of one quarter to one half inch in diameter. Younger wood is usually too angular to provide suitable buds. Cut the bud to include a thin piece of wood which keeps the shield piece of bark more rigid and facilitates its insertion under the bark of the stock If this piece of wood is removed it may injure the bud itself and often prevents good results. Buds put in during the spring may be forced into active growth by removing the upper portion of the stock immediately the bud has healed in, but buds put in during late summer and autumn are better left dormant till the following spring. If the top growth is then cut back the young bud will have the whole growing season to establish itself.

Young growths from buds and grafts should be suitably protected against injury from strong winds.

SUMMARY.

In conclusion it must be realised that in these days of keen competition and fluctuating markets the citrus grower in common with other primary producers must keep the cost of production at a minimum. This can only be accomplished by growing good commercial varieties on suitable soils in districts where natural conditions are not altogether uncongenial. Plant only those varieties suited to the district, and by scientific cultural methods endeavour to keep all the trees in a healthy and vigorous condition. Use care in picking and handling and by marketing only fruit consistently true to name and grade, build up a reputation for reliability.

Without unlimited capital you cannot keep an orchard. Make the orchard keep you.

Pigs—Management and Feeding.

G. K. Baron-Hay, Superintendent of Dairying.

During the last three years increased interest has been shown by farmers throughout the State in the production of pigs, particularly for the export market. This has been due to two main causes:—

Firstly—prior to the outbreak of war—to the British policy of fixing a price to the producer in Great Britain for bacon based upon the purchase price of offals. Subsequently to the outbreak of war this desirable condition to the Australian farmer has been continued by the arrangement of contract rates for the purchase of pig meats by the British Government.

Secondly—the low price of wheat during recent years, combined with an unpromising world outlook for this commodity.

Owing to the small extent of the local market, farmers are advised to concentrate almost entirely on those breeds and on the carcase weights which are suitable for the export trade.

TYPE OF CARCASE.

In view of the desire for leaner joints in both pork and bacon carcases, it is believed that the type, conformation, and general quality of carcases which meet the requirements of bacon curers will meet also those of the pork trade and vice versa, and the experience with recent shipments to Great Britain indicates that this is certainly so as regards the export trade.

It is undesirable and there is no need to introduce complications into pig production by requiring farmers to produce two distinct types of pigs according to whether they wish to supply the pork or the bacon market. In so far as any variations exist in carcases demanded by these two sections of the industry, such variations are those only of weight and not type, given proper methods of feeding.

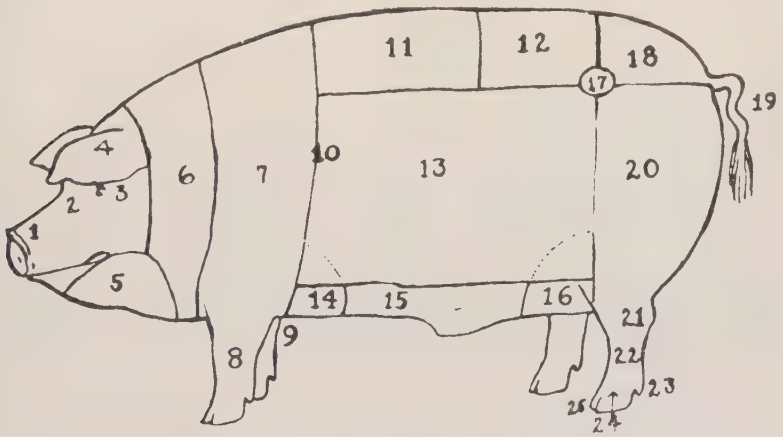


Fig. 1.

PARTS OF THE PIG.

1. Snout or nose.
2. Face.
3. Eye.
4. Ear.
5. Jowl.
6. Neck.
7. Shoulder.
8. Fore leg.
9. Chest.
10. Heart girth.
11. Back.
12. Loin.
13. Side.
14. Fore flank.
15. Belly.
16. Rear flank.
17. Hip.
18. Rump.
19. Tail.
20. Ham.
21. Hock.
22. Hind leg.
23. Dew claws.
24. Pasterns.
25. Toes.

This is of outstanding importance, as it is often assumed that different breeds or crosses are required to produce animals best suited to the pork and bacon markets respectively.

In order that the description given below of the Standard Pork or Bacon Pig may be understood, the various parts of the pig are indicated in the diagram in Fig. 1.

Carcases for Pork or Bacon should conform to the following specifications:—

DESCRIPTION OF STANDARD CARCASES FOR PORK OR BACON IN WESTERN AUSTRALIA.

The carcase must be that of a properly fed castrated male or virgin female pig.

The middle portion from the first rib to the hip or aitch bone must be long. The fore end must be light, with a light head and neck, and the hams well developed. Ribs must be well sprung, that is to say, they must not slope rapidly from the backbone, but clearly indicate where the back leaves off and the side begins. The line of the back must be slightly arched from head to tail, and not dished or humped over the shoulder. (See illustration 2.) The neck must be of medium length and devoid of crest. The shoulders must be smooth, slightly rounded from side to side over the top and very compact. The back fat should be even, without pronounced thickening over the shoulder, and it should taper slightly from the shoulder to the rump, and should not be greater than 1½ inches at the shoulder in the bacon pig.

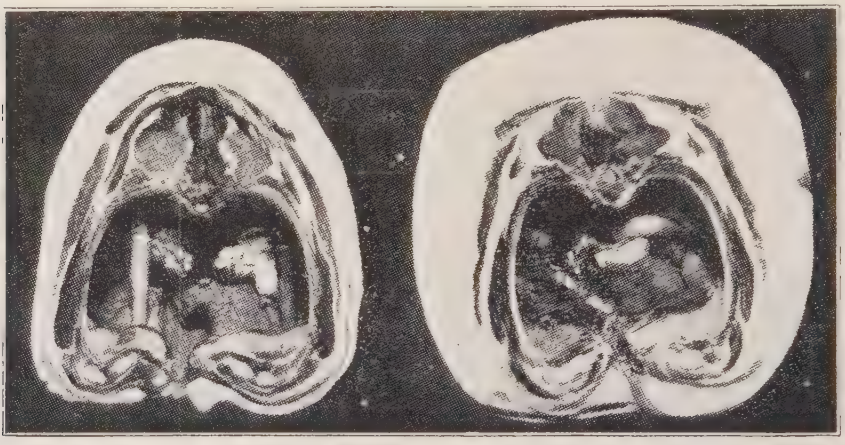


Fig. 2.

A transverse section through the shoulder should be arched. A flat or round section is usually excessively fat, and chest cavity, which holds lung and heart, is restricted. (Min. of Agric. Report on Emp. Pork and Bacon Trades, 1928.)

The underline must be straight and thick throughout its whole length, entirely free from flabbiness or distention of the flank. Thick lines or streaks of fat should be absent from the visible portion of the lean, and indications of leanness must be visible between the ribs.

The shanks must be short, bone fine, and the fore hock and ham free from wrinkles. The flesh must be carried well around the bone, leaving no bareness inside the thigh and well down to the knee and hock joints.

The vertebrae must be of a flesh pink colour and flinty in texture. The proportion of lean to fat must be good. The fat should be white and firm to the touch; when pressed with the thumb, an indentation should be formed which remains visible for a few minutes after pressure has been removed.

The texture of the lean must be fine grained, and not rough or fibrous. There must be no excess of internal fat—the kidneys should have a thin covering of fat.

The rind must be thin, flesh coloured, perfectly smooth, pliable and free from deep-rooted bristles, and must be devoid of any skin pigmentation. There must not be any indication of black bristles and no sign of "seedy cut."

Fig. 3.

A well balanced, well finished carcase, good loin development.

Badly finished carcase, uneven back fat, weak loin.

The following carcase weights are in most demand by the trade, and therefore are most profitable to the producer:—

	Carcase Weight.	Live Weight.
	lbs.	lbs.
Porker—		
Local	50–70	72–100
Export	60–90	95–120
Baconer—		
Local—Grade 1	100–115	143–164
Prime	116–130	165–186
Grade 2	131–140	186–200
Export	135–154	192–215

Farmers are advised not to market porkers of a less carcase weight than 60 lbs. or a greater weight than 90 lbs., although many such pigs are continually being forwarded to the sales. It is more profitable to "run" a pig over 90 lbs. to the bacon stage, as it is from this weight onwards that a pig shows the greatest daily gain. This weight is also an "out size" and not in demand by either the pork butcher or the bacon curer.

It may be unprofitable to continue to feed pigs beyond the weight desired by the trade because these "out-weights" may be difficult to market and, therefore, are "docked" by the purchaser.

The trend during the last few years has been for an increase in the number of Pig Sales being held at country centres. Whilst this system has many distinct advantages, unless farmers are particularly careful with the types of pigs being offered at these District Sales, there are certain disadvantages. The principal of these is a tendency for some farmers to forward pigs to the local market in an unfinished condition requiring perhaps two to three weeks' further good feeding to bring the pigs into their true carcase range. At such sales also it is essential that the quantity of well finished trade pigs should be sufficient to fill trucks for consignment to the main slaughtering centres at present in the metropolitan area. "Unfinished" pigs being presented at a sale have to be used on occasions by buyers to complete truck lots of well finished pigs, and, owing to the possible losses which may occur in keeping these pigs for a further two to three weeks at the Abattoirs, the result may be a general lowering of prices including that of the well finished ones. This condition of affairs, however, will be improved as the serious losses which may be occasioned by it are realised by farmers.

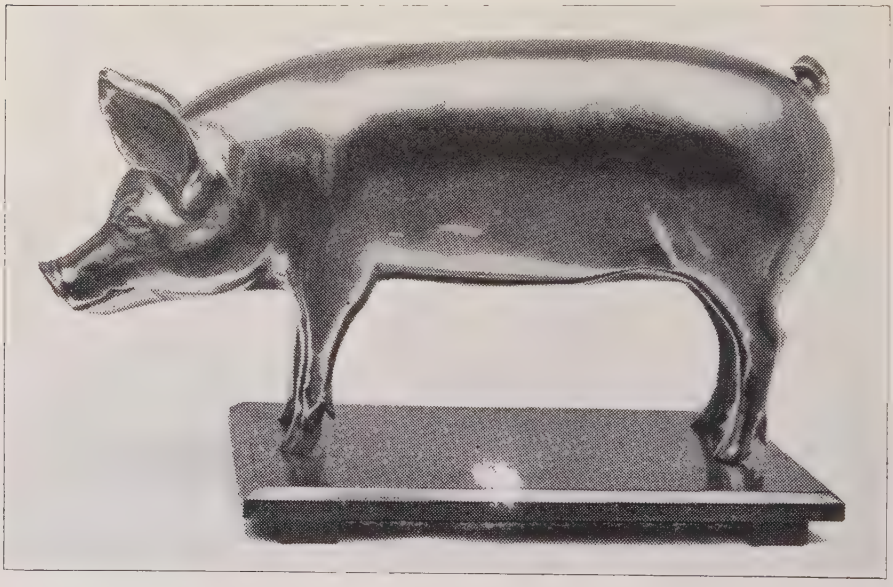


Fig. 4.

Model of Standard Type of Bacon Pig, in chrome-nickel, prepared by Western Australian Branch of Australian Pig Breeders' Association, as a guide to breeders and farmers in the selection of breeding stock for bacon production.

Carcases conforming to the description given above produce a high proportion of the best "cuts" whether as pork or bacon and are the product of selective breeding and correct feeding methods.

With the view of enabling farmers to see the type of pig considered desirable for both local and export trade, the West Australian branch of the Australian Stud Pig Breeders' Association has prepared a chrome nickel model of "The Ideal Bacon Type Pig," which was first exhibited at the Royal Show 1936 and

Fig. 5.

Short undesirable side, with too thick a layer of fat along the back, compared with lengthy side. Both the above sides are the same weight.

(Min. of Agric. Report on Emp. Pork and Bacon Trades, 1928.)

subsequently at as many country shows as possible. This is believed to be the first real effort in Australia for breeders to give a positive lead to farmers regarding type, and indicates their belief that within every breed it is essential to carefully select for the bacon type when considering the purchase or sale of breeding stock.

This model pig is illustrated in Fig. 4.

The task of the farmer is to supply the carcase which is described above and which involves two factors—that of "breeding" and "feeding," both of which are considered later in this article.

Breeds of Pigs.

Pigs or swine (*Sus scofa*) have existed in a wild state in Europe, Asia and Africa since the earliest known times, and a close relative is indigenous to the Continent of America. Pigs, however, were unknown in Australia until introduced after colonisation. It is generally accepted that the present day domestic pigs have descended from the wild species. Since the beginning of the Eighteenth Century, a rapid and continuous improvement in the types of a number of breeds of pigs has been effected in England, due to the skill of the English farmer as a stock-breeder and husbandman. Most of the English breeds of to-day have descended from the old English hog with occasional crosses of foreign pigs, particularly Chinese. The domesticated pigs will revert to the wild state if permitted, but the process is comparatively slow, and these pigs do not acquire the solitary habit nor become so fierce as the true wild hog.

Many breeds are recognised throughout the world, but, gradually during the last 100 years, those breeds which have been improved by English breeders have been recognised as of special value for improving native types in various countries. Even in England, however, at least 13 distinct pure breeds are recognised, so that, without special knowledge, the tyro in pig-breeding needs some guidance in the selection of his foundation stock. Four British breeds predominate in Western Australia, and it is proposed to describe only these breeds, as the main points of difference between all breeds are the size of the carcase and bone, the size and shape of head, length and thickness of neck, length and depth of body and legs, and the colour of the skin and hair, details of which may be obtained from the Breed Societies concerned should a farmer for any particular reason be interested in one of these less numerous breeds.

All the requirements of the existing market, both local and export, can be met by the crosses of the four breeds now in the State, and there is no useful purpose served by introducing new breeds and thus rendering the work of standardisation of type more difficult.

BERKSHIRE.

One of the oldest of improved breeds, origin Berkshire, England. Principal improvement in Leicestershire and Staffordshire. The original animal was large, similar to Tamworth, coarse of body, and the colour varied. Marked improvement developed early in 18th century, and was principally effected by Richard Astley and Lord Barrington. Berkshires were first given a separate class at Royal Agricultural Show, England, in 1862. Early writers show that Chinese pigs were crossed with the Berkshire in their improvement. The improved Berkshire was greatly used on native swine in Ireland and Scotland, with beneficial results. This breed is most widely distributed and popular throughout the world, and does well in all climates.

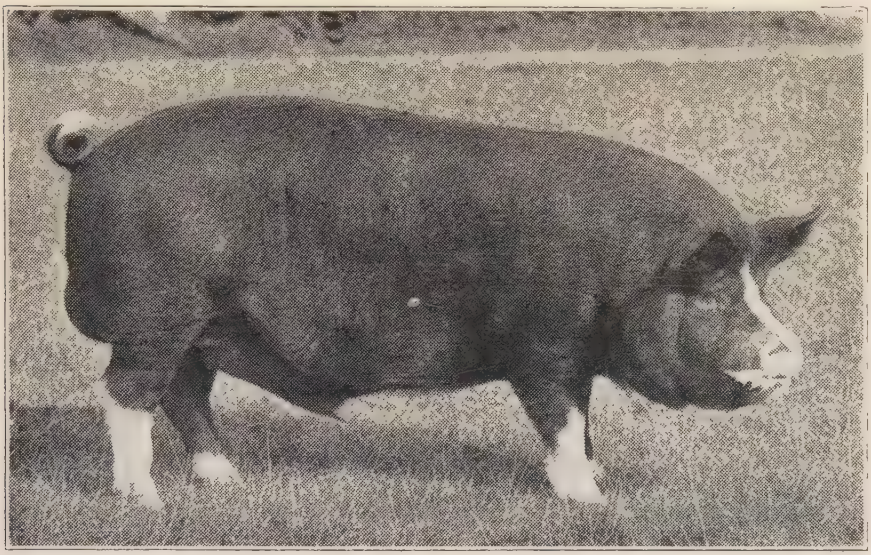


Fig. 6.

Berkshire Boar "Burnham Griqua Gaylad" 4009.

Winner of first prize at the Royal Agricultural Society of England's Show, 1935. Arrived Fremantle by s.s. "Coptic," 9/12/35. Destination—Denmark Research Station. One of four importations made by the Department of Agriculture during 1935.

Characteristics—

Size (relative).—Medium; originally larger than Poland-China, smaller than Large Yorkshire, Tamworth, and Large Black; improved strains similar to these breeds.

Adaptability.—In general adaptability they may be classed at head of all breeds for pork and bacon.

Maturing qualities.—Most excellent. Will fatten at any age.

Grazing and feeding qualities.—Splendid; strong digestive powers enable them to give a maximum return in flesh for food consumed.

Quality of meat.—Excellent pork and bacon. Well mixed fat and lean. Dresses well in proportion to live weight.

Value for crossing or "grading-up."—Unexcelled. Most used in this respect. Great value to refine coarse breeds. Quick growers; early maturers.

Breeding qualities.—Medium to good, but vary according to conditions. If not too confined produce fair to good litters, and are fair mothers. Boars are particularly noted for prepotency, and readily impress the young pigs with conformity and early maturing quality.

Principal points—

Head.—Medium, broad, fleshy, good width between eyes, well dished, snout short.

Ears.—Fairly fine, sprightly, cocked, inclined forward, fringed fine silky hair.

Jowl.—Full, firm, symmetrical.

Neck.—Short, broad, muscular.

Shoulders.—Sloping, freedom from coarseness, thick through chest.

Back.—Broad, long, straight or slightly arched.

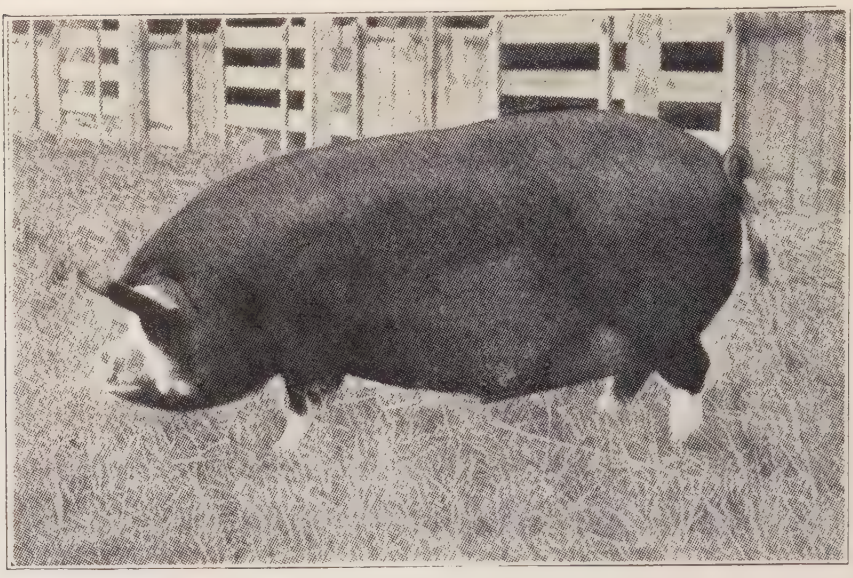


Fig. 7.

Berkshire Sow, "Burnham Griqua Maid" 14006. P.B.H.E.

Litter sister to boar in use at Denmark Research Station, 1935-36. Note fine shoulders and light head.

Barrel.—Ribs well sprung, deep, well let down even side and bottom line deep flank; loins strong.

Rump.—Wide, lengthy, square, showing strength.

Hams.—Deep and thick, well let down, joining back with hock.

Legs and feet.—Short, straight, strong, set well apart. Hoofs erect, firm and strong.

Skin.—Smooth, pliable, freedom from wrinkles.

Colour.—Black, with white blaze on face. White feet and white brush of tail.

Objections—

Snout, long; ears, flopping, coarse; chest, narrow; shoulders, coarse, heavy, open on top; back, drooping; sides, flat, not well let down; loin, narrow or weak looking; rump, drooping; hams, narrow, short; legs, crooked, weak, close together, round bone; feet, weak, flat; hair, coarse, curly, bushy fringe on neck; action, sluggish, clumsy.

Disqualifications—

Colour.—White, irregularly placed. Reddish hair or spots.

During the last twenty years a type of Berkshire pig, specially suited for modern bacon requirements has been developed in Canada. This Canadian or improved Berkshire, as it is known, has been produced as a result of continued selection of bacon type sows and boars, and differs little in conformation from other typical bacon type breeds. The improved Berkshire is rather longer in the snout and lighter in the head and jowl than the older type; the shoulder is finer and more sloping, and the sides flatter, resulting in less loose skin around the belly than in the older pig.

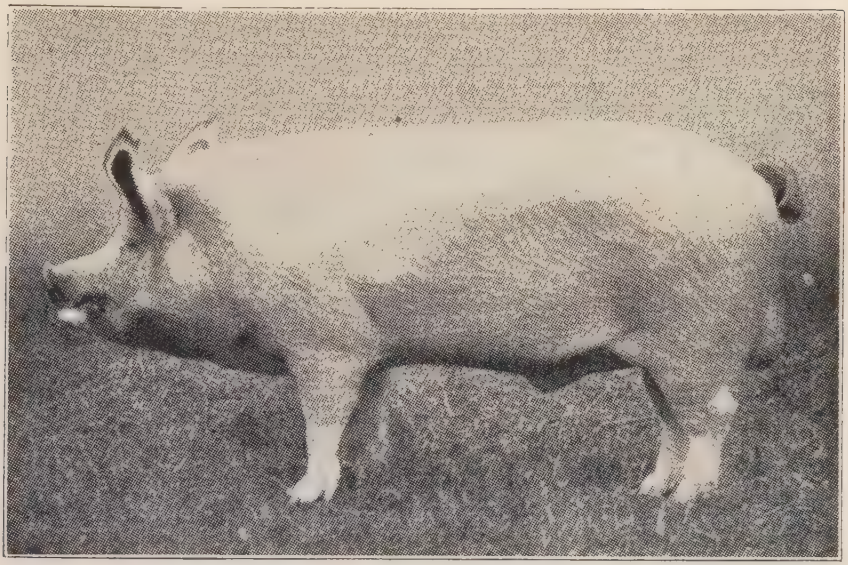


Fig. 8.

Large White Boar, "Wall King David 59th" 91213. S.P.B.H.E.

YORKSHIRE.

Origin Yorkshire, England. Bred from the old English hog, a large white animal. The Small Yorkshire derives its refinement from Chinese crosses, and the Middle Yorkshire from a cross between the two. The Middle Yorkshire was classed separately in 1852. Improvement commenced about 150 years ago. Yorkshire blood widely diffused throughout the world in all white breeds.

Characteristics of Large Yorkshire or Large White.

Relative size.—The Large Yorkshire is probably the largest of the breeds, and one of the heaviest, if not the heaviest. Middle Yorkshire and Small describe their size.

Adaptability.—Good for bacon and pork, especially where large sides are required. Good doers, good for crossing upon weaker types. Inclined to sun scald; prefers cool climates owing to this liability.

Maturing qualities.—Large Yorkshire not so quick as smaller varieties. Requires from six to eight months for market bacon.

Grazing and feeding qualities.—Graze and forage well in cool climate. Gentle disposition. Must be plentifully supplied with food to make economical flesh. Look wretched out of condition, then compare unfavourably with black breeds. Not as hardy as Berkshire. Good growers, especially if sty-fed.

Quality of meat.—Good, especially for large "side" markets. Fat and lean fairly well balanced. The Small Yorkshire excels as a porker.

Value for crossing or grading.—For small fine-boned sows good, will increase size, improve vigour, improve quality of meat, and increase prolificacy.

Breeding qualities.—Good, regular large litters and good mothers. Good tempered, gentle and tractable.

Principal points—

Head.—Long, lightish, wide between eyes.
Ears.—Long, fine, inclined forward.
Jowl.—Light.
Neck.—Long muscular.
Shoulders.—Sloping, no coarseness.
Back.—Long, wide, straight or slightly arched.
Barrel.—Deep, full rounded, well sprung ribs, flanks well let down, long, wide square.
Hams.—Broad, full meat to hocks.
Legs.—Straight and strong.
Feet.—Firm.
Skin.—Cream colour, freedom from wrinkles or dark spots.
Colour.—Pure white.

Objections.—Ears, coarse, flopping; shoulders, coarse; weak back; unshapely hams; weak loins; crooked legs; weak feet; coarse curly hair; action, sluggish.

Disqualifications.—Black or red hair on spots on skin.

Middle Yorkshire differs from Large Yorkshire in reduction in size, weight, length, and has a distinctly short snub nose and short neck.

Fig. 9.

Tamworth Boar, "Berkswell Up-to-Date 4th" 78813. S.P.B.H., Eng.
Improved type; note hams, capacious body, small head.

TAMWORTH.

Derives name from Tamworth, Staffordshire, England, where they have been bred for a long period. They are probably the oldest and purest of all breeds in Engand. This (as in all breeds of pure animals) accounts for the wonderful marked prepotency of the Tamworth. At the beginning of the 18th century they

were noted for large proportion of lean meat they produced. Have been greatly improved by selection, but it is generally conceded that no mixture of the breeds has been introduced in improvement. As early as 1847 they were given premier honours in competition with other large breeds at Royal Agricultural Show, England. Following this they went out of favour, but regained popularity from 1880 onwards.

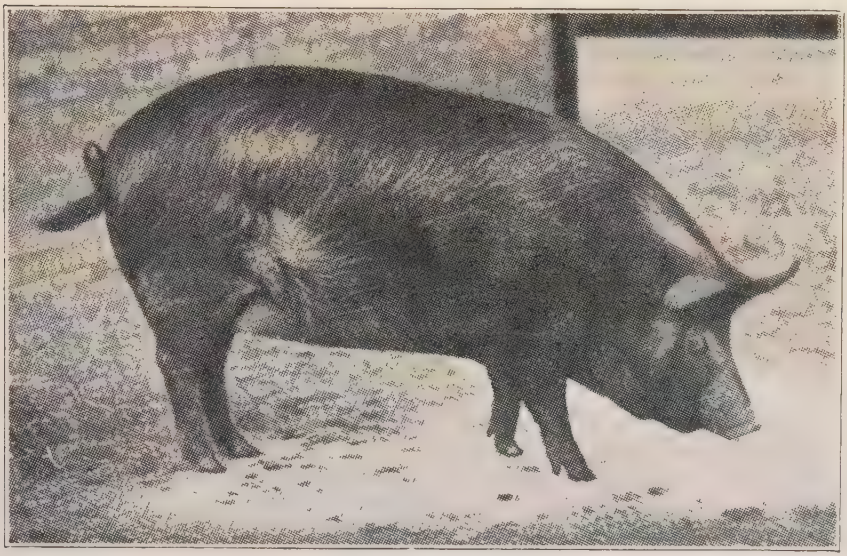


Fig. 10.

Tamworth Gilt, "Inge Velvet" 253930. S.P.B.H., Eng.
Imported for Muresk Agricultural College in 1935.

Characteristics—

Relative size.—At least second to Large Yorkshire, and in some cases even larger. Hardihood and vigour in keeping with size.

Adaptibility.—Unexcelled.

Maturing qualities.—Comparatively slow, not equal to the smaller or refined breeds.

Grazing and feeding qualities.—Excellent grazers, wonderful foragers. Exceptionally hardy; will stand forced feeding. Very suitable open conditions. Powerful digestion, but must not check growth.

Quality of meat.—Excellent on account of leanness. Exceptionally good to cross with to improve meat for bacon. Less waste in cooking, good flavour.

Value for crossing or grading up."—Excellent when crossed with small compact over refined grade sow. Impart size, development, vigour, and prolificacy, more and better meat (very big factor). Good growers. Good mothers. Excellent travellers to market.

Breeding qualities.—Unexcelled for prolificacy and hardiness, freedom of parturition troubles. Ideal mothers, rarely overlies her young, great defenders, good sucklers.

Principal points—

Head.—Long, lean, light, tapering to snout.

Ears.—Moderate size, fairly erect, pointing forward.

Jowl.—Light.

Neck.—Long, rather deep than wide, tapering.

Shoulder.—Sloping, good thickness through heart.

Back.—Moderately wide, long, slightly arched.

Barrel.—Long in coupling, deep ribs, well sprung.

Rump.—Deep, fairly full, rounded.

Ham.—Large, gradually rounded off rather than square.

Legs.—Moderately long, strong, firmly placed under body.

Skin.—Smooth, plentifully covered with hair.

Hair.—Freedom from coarseness.

Colour.—Bright golden red, no black.

Objections.—Shoulders coarse, open at top. Ribs flat, weak coupling, shallow body.

Disqualifications.—Black or white hairs. Black skin.

BREEDS RECOMMENDED.

As a result of a Conference held in 1930 at which Representatives of Breeders, Curers, and the Royal Agricultural Society were present, it was recommended that the Berkshire and Tamworth breeds and their crosses were most suitable for the production of bacon and pork under Western Australian conditions.

During 1930-35 a number of experiments have been carried out with these two breeds at the Denmark Research Station, Muresk Agricultural College, and on Mr. W. G. Burges's farm, "Tipperary," York, with a view to ascertaining further information as to the desirability of these two breeds in competition with the Large White Yorkshire breed. As a result, the recommendation is confirmed that the most useful pigs under West Australian conditions are the Tamworth and the Berkshire. Whatever breeds are utilised, however, types of sows and boars should be selected which conform to the bacon type, that is, good length, light shoulder, well developed ham, light jowl and small head.

In further trials where the carcases of various crosses have been forwarded to London, both privately and during the two years that the Perpetual Executors and Trustees Export Pig Trophy was being competed for, the London reports indicate that the Tamworth, the Berkshire, and their crosses were able to produce carcases, suitable for the British market. It is not suggested that the Large White and its crosses are not suitable for this purpose and do not produce a desirable type of carcase, but, even in this breed, selection is necessary to obtain a typical bacon carcase, and the average results show no greater percentage of high quality carcases than in the Tamworth-Berkshire cross. Moreover, curers in this State and in Queensland advise that this cross is suitable for their purposes, and a large and profitable export trade in pork has been built up by New Zealand principally with pigs of the Tamworth-Berkshire cross. Therefore, under West Australian conditions the recommendation is made that good type breeding stock of these two breeds should be purchased by small farmers intending to maintain a few sows.

BREEDING METHODS.

In-Breeding.

Generally speaking, in-breeding with pigs must be handled most carefully. No other class of stock shows the disastrous results of careless in-breeding so quickly, the first evidence being the birth of blind pigs, hermaphrodites, and abnormal individuals of all kinds. Mainly, however, the loss is through the weakening of the strain.

In-breeding is employed to improve quality, whilst out-crossing—the opposite of in-breeding—produces strength. In the hands of the expert breeder, in-breeding has its place in the development of type, quality and strength. The commercial farmer, however, would be well advised to depend upon the frequent introduction of fresh blood in the form of pure bred boars of the right type for improving his breeding stock.

Line-Breeding.

Although differing only in degree from in-breeding, careful line-breeding has been the origin of many of our best strains of pigs to-day. In this case the blood lines are similar, but the individuals are more distantly related.

Cross-Breeding.

The crossing of almost any two pure breeds of pigs usually will result in increased strength and vitality of the offspring. When two breeds of the same type are crossed, this same type is secured in the offspring with increased vigour. Such pigs invariably prove good "doers," thrifty, easy to feed and finish. The Tamworth-Berkshire cross is favoured, the sire being Tamworth. Because it is difficult for a farmer to maintain the two breeds and thus keep ensured a supply of pure bred females, cross-breeding in the true sense is not a widely followed practice, although, if pure bred sows are available for this purpose, the best results are obtained. The crossbred pigs should be used for market purposes only, and there is always the danger of utilising the crossbred progeny as breeders—a practice which frequently is followed by unsatisfactory results.

GRADING-UP.

The method of breeding which seems to offer the greatest source of revenue from the least expenditure for breeding stock is that of breeding up from common or grade stock through the continued use of pure bred pigs of one breed. Such grade brood sows, however, should not be selected as mothers unless the type which the farmer desires is strongly in evidence. Sows of this description can be procured for a small cash outlay, and, provided care is exercised in selecting a suitable pure bred boar, very rapid progress can be made in the development of a strain of bacon pigs which will produce carcases very little the inferior of the true crossbred or pure bred pig. This method of breeding pigs for market can be relied upon to give increasing numbers of pigs of the right conformation and type, and the percentage of high quality carcases will increase as the concentration of blood of the bacon breeds is increased through subsequent matings. The key to this system of breeding is the selected pure bred boar.

It is regrettable that there are a large number of crossbred boars still being used for breeding purposes, and, when it is realised the large number of pigs which such a boar can produce in even so short a period as twelve months—running into several hundreds—the folly of breeding from such an animal becomes very evident.

"Grading-up" therefore means using pure bred males of one breed for a number of generations. By starting with the ordinary sows available, and continuing the policy without deviation, a concentration of the desirable blood represented by the boar is obtained. By this means the "mongrel" blood is bred out, and a fixed type obtained. To ensure the improvement being continuous, the best sows from each generation should be selected as brood sows, and mated to another boar of the same breed as that started with; the breed of boar should not be changed, otherwise years of careful breeding may be wasted, and the whole process of grading up would have to be repeated. By such a definite policy as that outlined above, a pig breeder builds up good type and quality, shapely, quick-maturing and profitable commercial pigs.

SELECTION OF BREEDING STOCK.

General Considerations.

Once the decision has been made as to the particular breed that is to be used, then comes a very important phase in pig production—the selection of the proper sows and boars. With dairy cattle to-day, an animal is bought on its appearance, pedigree and production record. In some countries it is possible to select pigs on a somewhat similar basis, as a result of recording schemes being officially conducted in those countries. Such schemes are costly to conduct and require large numbers of recorded stock to make their conduction possible, and for this reason have not yet been introduced to Western Australia. These schemes enable breeding stock to be selected on the following three factors:—

(1) the ability of a sow to rear a large litter up to weaning stage;

(2) the rate of growth up to the bacon stage;

(3) the quality of the finished product.

In the absence of such recording schemes, animals can only be selected on their pedigree and conformation. The farmer who breeds his own sows is therefore in an advantageous position, as he is able to keep a record of litters, and need keep breeding sows from only the good performers.

In the first instance, a breeding animal should have excellent health and conformation. There are several external characters which are good indications as to the health and constitution of an animal. The hair should have a healthy appearance and be of the right colour, eyes bright and full of life, and also good blood circulation at the extremities, such as the ears, tail and feet. In white pigs the skin should have a rosy colour, and should not be dry, hard and "dead" white; the latter indicates absence of sufficient blood. Hair without any lustre and a pale colour of the mammary glands and scrotum are indications of poor health, and such animals should be discarded.

For a good conformation the breeding animal should show firmness and compactness with medium feeding. Soft and over-developed pigs are undesirable. The skin should be firmly drawn over the body, without wrinkles, and have a good covering of hair between the front legs and over the hams at the back of the sexual organs. Glossy, smooth hair is an indication of good food utilisation. Soft, thick, flabby ears and weak pasterns are bad signs.

THE HERD BOAR.

The herd boar may be responsible for up to 1,500 progeny during his life, and therefore his selection is a matter of paramount importance to the pig breeder.

On no account should anything but a pure bred boar be considered, and they can always be purchased at reasonable prices from breeders. If it is possible to obtain the information, a boar from a large litter, and from a strain of sows which throws large litters, should be chosen. In addition to pedigree, however, and whatever the breed, there are certain sex characters which should always be manifested by the herd boar. The head should be strong, is longer than that of the female, and should exhibit pronounced masculinity. After about five months of age, males show an increase in the size of the head, and thickening of the bones, thus in the mature boar one expects a strong head with what may be regarded a tendency to coarseness, as shown by the thickness of skin and coarse type of hair. Some boars develop shields, which are heavy coverings of tough hide on the shoulders. This is very undesirable, and a boar with smooth shoulders, or whose relatives have this character, should be selected. Although the tendency is for the male to become heavier in front than the female, this should not be excessive, as this character is inherited and passed on to the progeny. The scrotum should be well developed with two testes of equal size. It is fairly common to find young boars with only one testis, and since this is a hereditary condition, such boars should not be used for pedigree breeding.

If a boar is selected as a weaner, he should be fed intelligently with muscle, bone, nerve-tissue-forming foods or protein, his normal growth not checked, and given plenty of exercise. At four months it is advisable to separate him some distance from sows. He should not be used for stud purposes until 8 or 9 months old, and then only sparingly at long intervals—the first season 8 to 10 sows should be the limit, after that up to 40 or 50 sows may be served in the season if he is used judiciously. The boar should be properly penned with ample room for exercise, and provided with shade, shelter, and plenty of clean water. While developing and in season he should be well fed with nitrogenous foods with a reasonable amount of green stuff such as lucerne, peas, vetches and clovers, these being particularly good. When out of service, the ration should be considerably reduced, but the animal should not be allowed to fall away. It is advisable in hot weather or if sluggish to put sows to the boar early in the morning before feeding. If firmly and not harshly treated, viciousness may often be avoided, but in any case it is advisable to cut a boar's tusks—it is a safe policy. On no account should the boar be allowed to run with sows, as it is wasteful, and no record can be kept of farrowing dates.

THE BROOD SOW.

As the primary object of selecting brood sows is for the specific purpose of breeding stud stock, porkers or baconers, the matter demands a considerable amount of judgment.

The necessity of using a pure bred boar has been already stressed. In the case of sows, however, for stud breeding purity of blood is equally important, but as the raising of porkers and baconers does not necessarily demand the use of pedigreed sows, but rather those possessing certain special characteristics, a description of these qualifications is given. The brood sow must be sound, healthy, and bred from robust, healthy parents. She should possess an inherent maternal instinct, and natural capacity for producing and rearing large litters, in order that a maximum of profit may result.

To insure these points, the sow should be selected from a large litter, and from family strains known to produce large litters. Her colour type and characteristics should be in close conformity with those of the breed she represents.

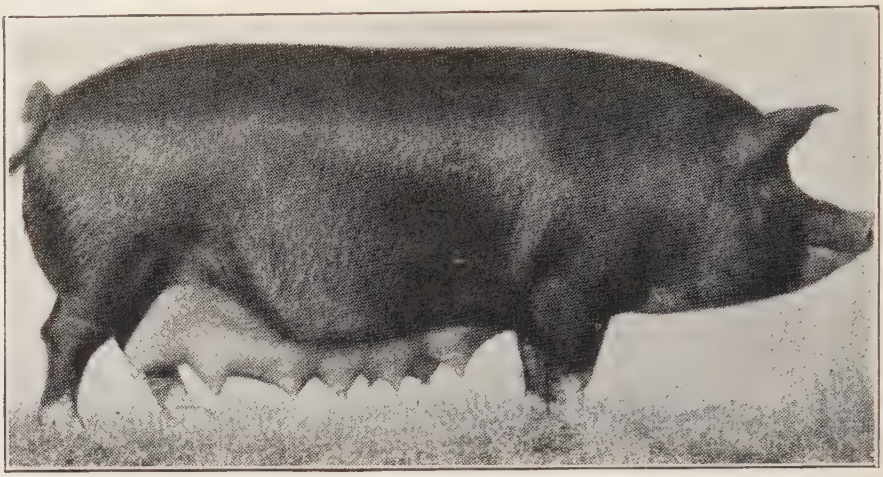


Fig. 11.
A typical brood sow of the Improved Type Berkshire.

In temperament she must be docile and contented, and unselfish when rearing her young. She requires to be of an active, thrifty disposition, with a capacity to consume and assimilate large quantities of food to benefit the embryo young or progeny rather than herself.

Soundness of constitution and robustness are indispensable, and these features should be associated with strong jaws, open nostrils, good width between eyes and ears, sloping shoulders (not coarse or open on top), strong, straight or slightly arched back, freedom from weakness at loins, long barrel, deep sides, well sprung ribs, square rump, good hams, sturdy straight legs squarely set on good feet, smooth mellow hide well covered with soft straight hair, 12 to 14 well placed properly formed teats. Summed up, the essentials are: freedom from coarseness, strength of back and loins, length and depth of sides, good hams, legs and feet, ample evidence of udder development.

MATING.

A *boar* may be put to light work at nine months old, an age at which if properly fed, his virility and masculine character should be sufficiently developed. Judgment, however, is required in mating, the size of both the young gilt or the young boar being a guide as much as the age as to whether it is safe to mate the animals. The male used also should be one that will tend to correct any faults that the female may have, which, however, should be only of a minor manner, otherwise the animals should not be used as breeders.

Well nourished *sows* usually show signs of sexual heat or oestrum when from five to six months old. This condition lasts for three to four days, and recurs every three weeks, until pregnancy occurs. Young sows should not be mated until ten months old, unless unusually well developed for their age. The result from breeding from younger sows, is that their nourishment of the foetus may impose a heavy toll on the vital functions of the mother, her development is limited, and the size and virility of the piglets may suffer.

The normal period of gestation is sixteen weeks (112 days). Under favourable conditions it is possible to rear two litters in twelve months. If permitted the sow will take the boar at the first oestrum period, which occurs three or four days after

farrowing. This exerts too great a strain on the sow, however, and larger, stronger litters are produced where service is delayed until after the piglets are weaned. Under these circumstances it will be realised that the boar should not be allowed to run with the sows, but should be kept in a separate yard, and only allowed with the sows when a service is desired, the date of which can be noted and the date of birth readily calculated.

While it is possible to obtain two litters in twelve months from sows, under practical farming conditions, such an average is seldom obtained. The practice means that pigs must be weaned at eight weeks of age, which is rather young, ten weeks being better, the weaners by this time being able to fend for themselves, and should suffer no "setback" when entirely removed from the sow. No allowance either is made for pigs failing to conceive, which would still further affect the two litters a year programme. Where a farmer owns a number of sows, say five or more, an average of three litters in twenty-four months per sow can be considered satisfactory.

The best returns will be obtained where the pigs are made to fit in with the other operations of the farm, that is farrowing should be regulated so that the weaners are most numerous when the farm feeds are most numerous.

On the dairy farm, weaners should be available to consume the surplus milk when cows are in full profit and pasture growth good. This would be from May to October, necessitating mating from January to June.

On wheat farms, this period would be after the wheat or barley crop has been harvested, about January to March, in which case special provision must be made to compensate for the absence of skim milk and green pasture.

During pregnancy sows must be allowed plenty of exercise, and this can be insured by keeping all breeding sows on the "open air system," that is allowing them the run of a field, the size being immaterial, and if large enough for grazing so much the better. A weather-proof shelter will be required in the winter, but only shade and ample water during the summer months.

THE PREGNANT SOW.

The pregnant sow is called upon to peform a double function—that of nourishing herself as well as the litter of pigs she is carrying. It is therefore imperative that she receive a ration that will supply all material necessary for body building, and plenty of it. Grazing on lucerne or clover pasturage is of great assistance. Sows, however, should not be permitted to get overfat. The effect on the litter is nearly as serious as if the sow becomes emaciated and very thin. The over-fat sow is likely to farrow small litters, and often kills a number of pigs by lying or trampling on them. Often too she has not enough milk and is a poor mother.

The best guide as to whether pregnant sows are being sufficiently fed is the condition of the sow herself; if she is getting too fat, then the ration is too liberal and probably contains too much starchy material, such as maize or wheat grains.

Under dry conditions it may not be possible to provide any green fodder for pregnant sows, and it is necessary to provide those nutrients which normally would be found in such fodder. These nutrients can be supplied in the form of certain animal oils, particularly cod liver oil or oil made from the extracts of other fish, cheap brands of which have been prepared specially for stock and are on the market in Australia. One dessertspoonful of such liver oil per day is recommended to be given to each sow during the times that no green material is available.

BEFORE FARROWING.

About ten to fourteen days before farrowing is due, the sows should be brought in from the paddock and put in a separate pen. It may be necessary to reduce the ration somewhat until after farrowing as the sows will get less exercise than usual while confined to the farrowing pens. The food can be made more laxative, by increasing green material, the use of bran, or by giving 3-4 ozs. of Epsom salts in the slop if considered necessary.

About 8-12 hours before farrowing the sow will exhibit restlessness, and may be seen gathering straw in her mouth and making a nest. It is inadvisable to have a great quantity of bedding available, as the young pigs get underneath this, and are crushed by their mother.

The farrowing pen need not be elaborate—it should be well ventilated, but not draughty, and should have a stout rail all round the inside, about eight inches from the ground. The young pigs are pushed under this when the sow is lying down, and so avoid being crushed.

The young sow should be closely watched at farrowing time, the after-birth removed, and the blood cleaned up, a little slaked lime being spread about. A taste of blood may mean that the sow develops the habit of eating her young, and then must be fattened and slaughtered.

FARROWING CRATES.

Sometimes it is found that certain sows are clumsy during the first few days after farrowing, before the piglets are active, the result being the crushing of the young pigs. It may be undesirable to discard some such sows because of their otherwise excellent characteristics, and in such instances the use of a farrowing crate may be beneficial. The sow is permitted to farrow in these crates, and must be let out for exercise and feed several times during the day, and at such times is away from the young pigs. Because of the extra labour involved, it is doubtful if the use of the farrowing crate will be economical in commercial piggeries, where stout farrowing rails are provided in the farrowing pens.

For the first 24 hours after farrowing, the sow should not receive any food, and after that for the first week the food should be sloppy, laxative and light, a mixture of ground oats and pollard in equal proportions in skim milk being a favourite and satisfactory ration. Plenty of clean water should, however, always be available.

It is inadvisable to lay down the amount of meal to be fed, which will vary with every sow and with every litter. This must be divided by the feeder—as a guide the sow may require 3-4lbs. of meal per day during the first week, increasing to 5-8 lbs. per day at the end of the first month.

During the summer, when no green roughage is available, good meadow hay chaffed, or lucerne chaff that has been soaked for about 12 hours, may be mixed with the meal and fed with satisfactory results. About ½lb. of chaff per day will be sufficient.

There are usually one or two runts in a large litter, and it will be advisable to destroy these when the piglets are a week old; as they will seldom thrive, in comparison with the rest of the litter, and have to be marketed at a later period.

When the young pigs are three weeks old they should be induced to eat by providing a small trough, which is in a pen made of vertical slabs, about 5 to 6 inches apart, which will permit the piglets to pass through, but will exclude the sow. The sow should be fed three times daily.

At four to five weeks old the young males, if not required for breeding, should be castrated.

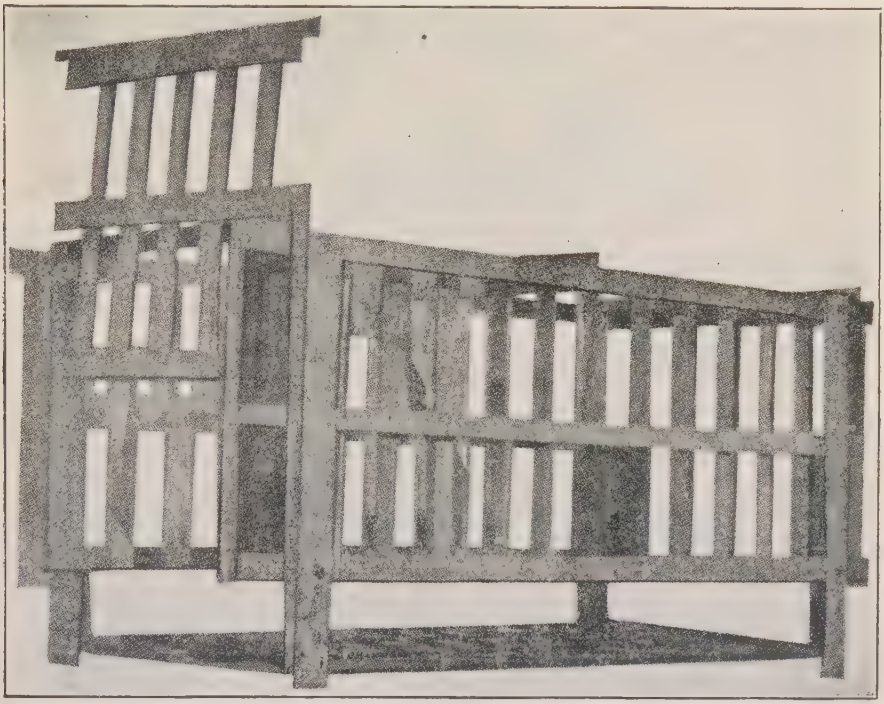


Fig. 12.

A farrowing crate; length 8 ft., width 3 ft., bottom rail 10 in. from floor, with a drop door at either one or each end.

(J. of Agric., Queensland.)

WEANING TIME.

There is a tendency to wean piglets at too young an age—quite commonly weaning is complete by the time piglets are 6 weeks old. This is too young, the pigs generally suffer a check in growth, and take several weeks to recover. Experience has shown that it usually pays to delay weaning until the pigs are 8-10 weeks old, and it will thus be hardly possible to obtain two litters per year.

Weaning should be effected by removing the pigs once and for all from the sow. If they are weaned slowly, by allowing access to the sow at gradually lengthened periods, the young pigs expect the drink, and do not settle down so rapidly as where the change is effected decisively.

The most effective way of weaning pigs is to remove the sow from the litter. This has the advantage that the young pigs are not removed and also subjected to new surroundings.

As soon as the weaner pigs have become used to the absence of the sow, then they may be removed to the field or pen in which they are to remain until about porker weights.

If weaned at 8-10 weeks, it will be found that the sow will seldom be inconvenienced by an accumulation of milk, as occurs if weaned at the age of 6 weeks.

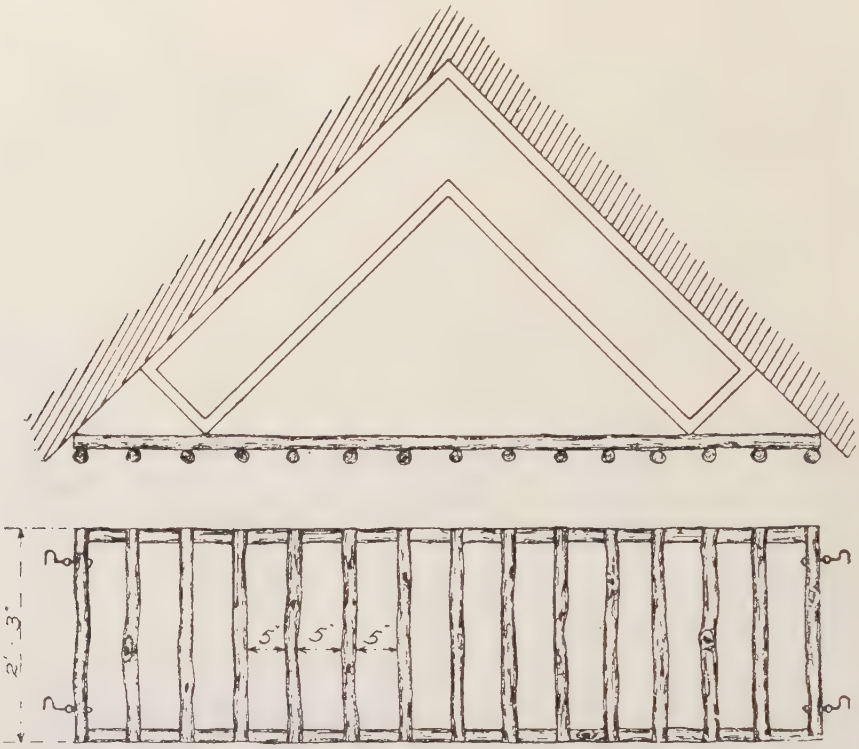


Fig. 13.

Pig Creep used for feeding young pigs prior to weaning.

(Dept. Agric., South Africa.)

FEEDING THE WEANER.

The most satisfactory ration for weaners is one composed of either separated milk or buttermilk, preferably the former, with one of the following grain concentrates:—ground barley, ground wheat or pollard, in the proportion of three parts by weight of milk to one part of meal. Green roughage should also be available.

In the absence of milk a fairly thin slop with water composed of ground wheat 5 parts, pollard 4 parts, meat meal 1 part has given satisfactory results.

The weaners should be fed only what they will clean up in about 10 minutes, and care should be taken to see that the troughs do not become foul or dirty. By the time the pigs are 12-14 weeks old the critical time after weaning is past, and feeding for either pork or bacon production can be commenced.

SEGREGATING ACCORDING TO SIZE.

It is advisable to segregate growing pigs into pens or small fields according to size. This is not so important where pig paddocks are large and self-feeders are being used as where the conditions are such that pigs are being fed in troughs. It is essential, however, to have growing pigs divided into at least *two* classes, namely, those from weaner to porker stage, and those from porker to the finished baconer stage. The reason for this is that pigs should be grown with a full ration

to approximately porker stage, i.e., 90 to 100 lbs. live weight, and thereafter such pigs should be fed a slightly different ration which is not so "forcing" as that used in earlier growth, so as to induce the deposition of lean meat at the same time that fat is being laid on during the latter weeks of feeding. The effect of this is to produce a leaner type of carcase, which, although well filled, has fat and lean intermingled throughout the carcase.

IDENTIFICATION OF PIGS.

It is often convenient on commercial farms and is essential on stud pig farms that some simple method should be available for identifying pigs. Where white pigs are being bred, a tattoo number similar to that which is used for the identification of cattle may be placed in the ear, but no satisfactory ink has yet been found for use with black or red pigs. Tags are often used, but are unsatisfactory, as they tear out very easily. By means of notching the ear, the notch being about half an inch into the ear, an animal can be identified without handling it, and this method is found the most satisfactory.

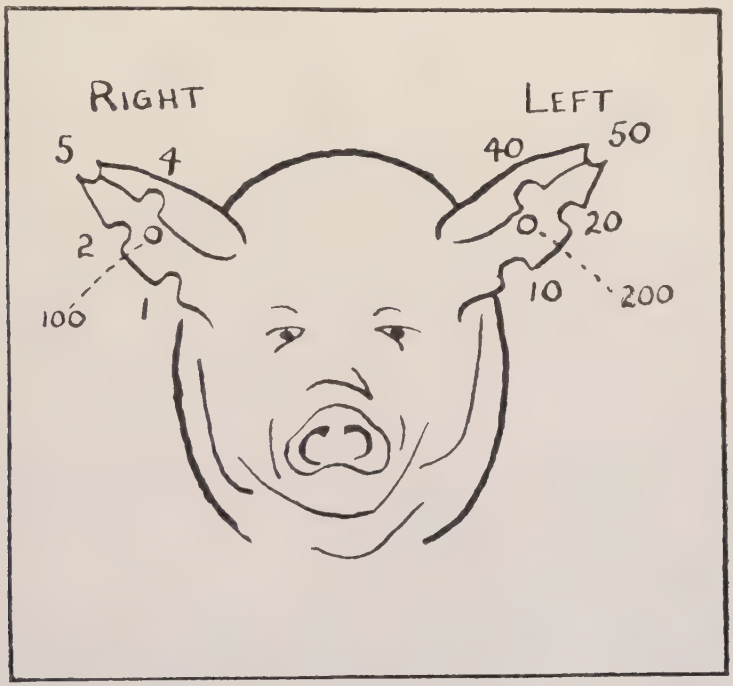


Fig. 14.

No. 3 = notches 1 and 2; No. 9 = notches 5 and 4, etc.

The above diagram illustrates a method which has been in use for several years in the Department of Agriculture and found satisfactory. Numbers up to 399 may be used by this method and, if different shapes are adopted for the holes in the ears, indicating hundreds, this number may be still further increased, but, as a rule, by the time the final number of 399 is reached, all pigs with the earlier used numbers will have been slaughtered or have died, and a start can be made again with number 1.

FEEDING.

In providing rations for any animal, the object in view is to adjust the ration so that it may provide the material and energy required to enable the animal to produce the desired result, which is the production of meat in the case of the pig. In order to achieve this object, it must be remembered that part of the ration is required to maintain the vital functions of the animal, and it is only the excess of the ration over these maintenance requirements (*viz.*, the energy required for breathing, digestion, circulation of the blood, etc.) which can be contributed towards production. In the case of a pig, however, no farmer desires to maintain his pigs at a constant weight, but endeavours to produce an increase in weight of 1 lb. per day at least. If is customary, therefore, to include the foods necessary for maintenance in any ration which is fed without specifically referring to it as such.

In considering foods they can be divided into two main divisions :—

1. Water.
2. Dry matter.

1. *Water.*

The water supply for pigs should be clean. Where this supply is contaminated from decomposing organic matter, as in dams, waterholes, swamps or pools, this water may be a prolific source of diarrhoea, dysentery, worms, and other digestive troubles. A plentiful supply of clean water is of particular importance during the summer months when pigs generally drink water to excess as a means of maintaining an equable temperature in their body.

Experiments at the Illinois Experimental Station have shown that fully grown sows weighing 300 lb. may drink up to three gallons of water per day during hot weather. Much, however, depends on the condition of the animal and the time of the year, but the above will indicate the necessity for an ample supply which should be available always.

In evaluating foods, it is desirable that the groups of substances into which the food can be divided, and the use to which these groups are put in the body of the animal, should be known.

2. *Dry Matter.*

The "dry matter" is the fodder after all moisture has been expelled and includes the mineral matter or ash. This dry matter contains all the nutrients from which energy is developed, wear and tear made good, and new tissues built up. In addition, the dry matter supplies bulk to the ration, which is necessary for digestion to proceed normally.

The dry matter of foods is divided into five groups of nutrients, namely:—

(a) Crude protein or nitrogenous material.
(b) Carbohydrates or starchy material.
(c) Fats, oils, etc.
(d) Fibre, which in the case of the pig may be regarded as indigestible.
(e) Ash or mineral matter.

(a) *Protein.*

The protein is an essential nutrient in the support of animal life, and can only be produced in the animal from foods which contain nitrogenous material. Its special use is to produce blood, milk, lean meat, muscles, tendons, nerves, skin, hair, hoofs, and the gelatinous parts of bones, etc.

Remembering that the pig is one of the fastest growing farm animals and lays on meat more rapidly than other stock, the question of the supply of suitable protein or nitrogenous material in the rations is of paramount importance.

(b) *Carbohydrates.*

These substances which contain no nitrogen are the primary source of heat and energy and are associated with foods containing starch, sugar, fibre, etc. In addition to providing heat and energy, they also may be used for laying on fat. They form the bulkiest parts of all foods and are usually comparatively cheap to purchase.

The pig possesses the power to a markedly high degree of converting these carbohydrates into fat in contrast with other farm animals. For this reason, where the public taste now is for lean bacon and pork, and also in Western Australia where the temperature is comparatively high, care should be taken not to increase the carbohydrates in the food beyond the amount required for health.

(c) *Fats and Oils.*

Fats and oils in foods are also energy and heat producers, and, in the case of the pig, exert an influence on the firmness, appearance, and composition of the fatty flesh. Generally speaking, foods containing large quantities of fat or oil such as linseed meal, cocoanut cake, and cotton seed meal, produce a soft fat in the carcase which is undesirable. Fat will provide about 2½ times as much heat per lb. as the carbohydrates, and its quantity, therefore, should be kept as low as possible in the ration.

(d) *Fibre.*

A certain amount of fibre is necessary in all rations, but, as the stomach of the pig is small, the quantity should be limited to approximately 10 per cent. in the case of young pigs, and below this in the case of pigs which have been weaned recently.

Fibre is best supplied in the form of green feed, though, during the summer months in Western Australia, it may be necessary to feed chaffed meadow hay or immature oaten or wheaten chaff in order to provide this roughage.

(e) *Ash or Mineral Matter.*

It is essential that adequate supplies of mineral matter should be available for the growing pig. The minerals which are usually lacking are lime, phosphorus, and chlorine, which, if required, could be provided in the form of bonemeal, slaked lime, di-calcic phosphate, or salt.

As the rations of pigs usually contain a large proportion of grain, which is high in phosphoric acid, lime is usually the element which is lacking.

It is not sufficient, however, to know the chemical composition of foods, which supplies information regarding the relative quantities of each of the five groups of nutrients mentioned above, because the whole of these substances are not available to the animal but only those portions which are digested.

Further, some foods are particularly difficult to digest, and the energy expended in digestion also must be deducted from the food in order to arrive at its true value. A ration containing a high percentage of chaffed wheat straw may

be definitely detrimental, as the pig would be unable to digest this roughage, whereas such a ration fed to a ruminant might supply some energy towards the maintenance after the cost of digestion has been deducted.

A considerable amount of work has been carried out by experimental stations in America and Great Britain to discover the net value of various fodders for different types of stock, and these figures are usually those which are utilised in comparing the value of different foods.

The following Table 1 sets out the percentage of digestible nutrients in those foods which probably would be available in Western Australia, and also supplies information regarding the percentage of protein to non-protein matter in each food. This percentage figure is called the nutritive ratio.

Table 1.

FOODS SUITABLE FOR PIGS.

Digestible Nutrients in 100lbs. Dry Matter.

Foodstuff.	Dry Matter.	Crude Protein.	Starch Equivalent.	Nutritive Ratio, 1 :	Effect on Bacon.
Cereal Grains—	%	%	%		
Barley	88	9.3	85	8.4	Very Good.
Maize	87	8.4	94	10.3	Excellent.
Oats	88	8.0	71	8.3	Good.
Wheat	88	10.2	83	7.5	do.
Leguminous Grains—					
Peas—Field	88	22.0	84	2.9	do.
Lupins	86	27.4	75	2.1	
Concentrates—					
Bran	88	14.6	54	3.6	do.
Linseed Meal	88	22.1	129	5.0	With care.
Meat Meal	92	65.0	100	0.62	Good.
Pollard	88	15.5	80	5.6	do.
Skim Milk ... ... / Butter Milk	10	36.0	91	1.5	do.
Green Fodders—					
Lucerne :					
Bud	20	19.0	52	2.4	
Full Flower ...	25	14.0	42	3.0	
Maize	22	5.0	57	13.0	
Rape	14	17.8	58	2.9	
Subterranean Clover :					
Young	18	19.0	68	2.9	
Hay	25	10.8	44	4.4	
Mature	90	4.5	30	10.0	
Potatoes	21	1.1	18	16.0	

The compounding of rations for pigs is a comparatively simple matter, if it is remembered that the stomach of the pig is small and that substances which would be extremely bulky in order to supply the nutrients required are unsuitable for feeding to pigs.

As a guide, the quantity of grain consumed by a pig is approximately 1 lb. per day for each month of age of the pig, in addition to an ample supply of water. If this weight of food is supplied, then all that is necessary to do is to ensure that the proportion of protein to carbohydrates should be correct.

The following table sets out the nutritive ratio required in rations for pigs of varying weights, which will enable suitable feeds to be supplied:—

TABLE 2.

NUTRITIVE RATIOS FOR PIGS OF VARYING WEIGHTS.

		Protein.		Carbohydrates.
Sows with litters require feed balanced		1	to	3.5
Pigs 40 to 100 lbs.	fattening	1	„	3.5 to 4.0
100 „ 150 „	fattening	1	„	4.5
150 „ 200 „	fattening	1	„	5.0
up to 200 „ 300 „	fattening	1	„	6.5
Boars 300 „ 500 „		1	„	5.5 to 6.5
Sows (pregnant) 200 to 350 lbs.		1	„	5.5
Sows (gilts) 150 „ 300 „		1	„	5.0

The following example in calculating a ration to feed six pigs weighing from 100 to 150 lb. each will indicate the use of Tables 1 and 2 above in compounding rations:—

From Table 2 it will be noted that such pigs require a nutritive ratio of 1 : 4.5. The foods which are available are wheat, pollard and skim milk. By referring to Table 1 the compositions of these foods can be ascertained, the calculation then being as follows:—

	*Protein.	†Non-Protein Nutrients.	
100 lbs. wheat	9.0	67.5	
50 „ pollard	6.9	38.6	
300 „ skim milk	10.8	16.2	
	26.7	122.3	= 1 to 4.6

From Table 1—

* 100 lbs. wheat contains 88 lbs. dry matter; 88 lbs. dry matter contains $10.2 \times \frac{88}{100}$ digestible crude protein = 8·97 (approx. 9.0).

† Non-protein nutrients = digestible crude protein × nutritive ratio.

Another Example—

	Protein.	Non-Protein. Nutrients.	
75 lbs. maize	5.5	56.6	
50 „ pollard	6.9	38.6	
375 „ skim Milk	13.5	20.2	
	25.9	115.4	= 1 to 4.5

Either of the above rations, therefore, would be suitable for feeding to pigs weighing 100 to 150 lbs. live weight.

Quantity of Feed.

Although usually pigs are fed an amount of ration which they will "clean up" in from 10 to 15 minutes, or, in some cases, are fed through a self-feeder, it is desirable that the farmer should be able to estimate the quantity of any ration which pigs of various weights should receive.

As the various concentrates usually fed are mixed in certain proportions so as to give a nutritive ratio suitable for the type of pigs being fed, it is only necessary for the correct amount of protein to be fed in order to ensure that the pigs are receiving all they require. This amplifies the feeding of pigs considerably in comparison with dairy cows.

Fig. 15.

The effect of four methods of feeding, as shown by cut through chest cavity:—High-high: Pig force fed from birth to bacon weight, overfat, and side short, wasteful flap in belly. High-low: Pig force fed to porker stage, and then growth slowed down till bacon weight of 200 lbs. live weight, well balanced lengthy carcase, meat and fat in right proportion, good streak. Low-high: Pig kept in good store condition to porker weight and then "topped off" rapidly by forcing ration, too fat, small development of lean meat, wasteful belly. Low-low: Pig fed so as to maintain good store condition till bacon weight of 200 lbs., slow development, too much lean.

[J. of Ministry of Agric., England.]

The following table sets out the daily quantities of protein which should be fed to pigs of varying weights, and, knowing this figure, it is a simple matter to calculate the pounds of any particular ration required to supply this amount of protein.

PROTEIN REQUIREMENTS OF PIGS.

Live Weight. lbs.	Digestible Protein. lbs. per day.
50	0.30
100	0.50
150	0.56
200	0.61
250	0.66
300	0.69

GENERAL CONSIDERATIONS.

Grinding or Soaking Grain.

Whether the grinding of grain for pigs is profitable is a matter of great economic importance, and the result of experiments now enables definite information to be given. With a large grain such as maize, it is immaterial whether or not the grain is ground, as it is so large that pigs are unable to swallow it without crushing the grain. With small grain, however, such as wheat, barley, oats, and peas, much of the grain passes through the animal undigested, and grinding or crushing is definitely desirable. The smaller the grain the greater the amount undigested, the saving effected by grinding varying from 8 per cent. to as much as 22 per cent. according to the grain used.

Regarding the soaking of small grain, experiments indicate that the soaking of the foods is unnecessary, and it is because of this that self-feeding becomes economically possible. In cold countries pigs are often fed their ration in the form of slops as a means of inducing them to consume greater quantities of water, but, in a climate such as Western Australia, this is unnecessary.

Cooked Foods.

Early agriculturists strongly advocated the cooking of food for pigs, but numerous experiments have shown conclusively that, instead of a gain from cooking, there is in nearly every case a loss. In twenty-six trials in America, using corn, barley, rye, peas, either separately or in combination, it was found that there was a loss of approximately 10 per cent. in digestibility through cooking. The only common food in this State which benefits from cooking is the potato.

Limited Feeding versus Full Feeding.

One of the most important questions that every pig-raiser has to decide is how much grain he will feed his fattening pigs. It is known that the larger the amount of grain fed, the faster will be the gain in weight, whether the pigs be running on pasture or are sty fed, but there is some doubt whether there would not be more profit if sometimes the amount of concentrates fed were restricted. This is particularly so, as the market demand is for a relatively lean type of carcase.

Several considerations affect the economy of the practice of full feeding. At certain times of the year the prices for pig products are higher than the average, such as during December for the Christmas market, and there is generally a shortage of pigs from March to June, and it may pay to full-feed in order to hasten maturity, so as to obtain the benefits of this higher market.

Experiments conducted in Great Britain and also at Mr. W. G. Burges's farm, "Tipperary," York, last year indicate, however, that full feeding may not only be unprofitable at certain times of the year, but tends to produce an over-fat carcase which is not desired by the trade. In the experiments at York, however, rather than restrict the bulk of ration being fed, the quantity of roughage in the ration was increased, although there is apparently no benefit through increasing this roughage beyond 10 per cent. The roughage utilised should be first quality meadow hay or cereal chaff.

The result of this practice is to delay the period of maturity, but tends to produce a lengthy and leaner type of carcase.

Home-grown Foods.

From the previous discussion dealing with meal mixtures and purchased concentrates, it may be inferred that these fodders constitute the main foods for market pigs. A feeder may be able to produce excellent market pigs and yet, at the prevailing price the result of his operations may be a definite loss. Profits from pigs, as with other types of animal production on the farm, are largely controlled by the ability of the feeder to make the best use of the foods which he finds to hand, or that he can produce on the farm at a low cost. It may be necessary to supplement these home-grown fodders by the purchase of certain concentrates, but the more these former fodders are consumed in proportion to purchased foods the greater will be the ultimate profits.

Grains.

Wheat.—In Western Australia the principal grain which will be used as a basis for pig-feeding is undoubtedly wheat. Wheat alone, however, is not a complete ration for growing pigs, being low in protein for flesh-building and also lacking in mineral matter for skeleton formation. This grain should predominate in the ration of pigs fed in dry areas, and it has been shown to be possible to produce a good market pig on nothing but crushed wheat, milk or meatmeal and the necessary mineral requirements. While such a limited ration is by no means recommended, it tends to show the possibilities of this grain.

Barley.—Barley is a grain which can be grown in the South-West portion of the State and is the equal of wheat for the production of high quality pork or bacon. As with wheat, however, suitable supplements are required.

Oats.—In the Dominion of Canada, oats is regarded as the best single grain for market pigs and is said to have a peculiar value in the development of a long and lean carcase. The quality of oats, however, grown in Western Australia is not suitable for forming the bulk of the finishing ration, as pigs do not fill out on this grain but tend to keep in store condition. When feeding oats, quality is essential. Light, shrunken, poorly filled grain is of little value.

Peas.—This grain can be grown to advantage throughout the dairying districts of the State and is excellent as forming part of a "topping off" ration—either fed ground or by permitting the pigs to harvest the grain from the field. The quality of bacon from pigs fed on peas is excellent.

Fig 16.

Sows grazing on good mixed pasture need little other feeding until near farrowing time.

Pasture and Green Feeds.

Pasture undoubtedly may be put to good use on the average farm. During the winter months when pasture growth is at its best, little else is rquired for growing pigs.

Where pasturing is employed, lucerne and clover are the best crops. Oats or barley, if fed when six inches high, give excellent results. Rape is another useful crop and is best suited for pigs from the porker to the bacon stage.

In every instance where pasture is available, pigs will thrive better if some skim milk is available also.

For brood sows and young breeding stock, pasture provides not only the cheapest but the most healthful method of feeding For pregnant sows, such outdoor conditions prove ideal and little else would be required.

Roughages and Succulent Foods.

During the summer months it is impossible on the average farm—unless irrigation is available—to provide green fodder crops for pigs. Experiments have shown that lucerne hay, subterranean clover hay, or early-cut meadow hay are very valuable foods for the brood sow in particular, but also for the market pigs. Such hay should be fed in racks from which the pigs will procure the roughage as required.

Pigs require fibre and will get it in some form or other if only through eating straw or bark of trees. Comparatively little is eaten per head—not more than about ½ lb. per day—and there is ample evidence to the effect that it promotes thrift and health in the pigs.

Milk Products.

As a class, these form the most valuable of all pig foods either purchased or home grown. Experience in Canada has shown that, where no milk at all is available and weaners are abruptly removed from the mother to a milkless ration, a low percentage of selected grade hogs usually results. Even a small quantity of milk, however, seems to supply the nutrients that are lacking, and it should be seldom in Western Australia that milk would be entirely impossible to obtain. Meatmeal practically can replace skim milk in the ration. Skim milk and butter milk generally are classed as of equal value.

In evaluating skim milk, 3 lb. of skim milk is equal to 1 lb. of grain in feeding value. Whey may be regarded as of about half the value of skim milk. It is not as valuable as skim milk for young pigs, but fulfils the function of skim milk in pigs of the porker and bacon stage

The farmer with a home-produced milk by-product at his disposal has the cheapest, safest, most productive, most palatable and surest feed available, and the one item of diet that should ensure the quality and type of the finished baconer.

Foods that may be Purchased.

It may not always be possible to feed pigs entirely on home-grown foods. In fact, the greatest returns are seldom obtained by this practice. In Western Australia the purchased grains will be by-products of wheat, barley, or oats. Bran is the most valuable and widely-used wheat by-product for stock generally. It is palatable and peculiarly useful on account of its laxative qualities, and, for this reason, forms a standard food for the brood sow during the fortnight before farrowing when she is usually hand fed. Pollard, however, is more suitable for feeding to fattening pigs and has not the laxative effect of bran, the feeding value of the two being approximately the same.

Slaughter House By-Products.

On wheat belt areas where skim milk is available only in limited quantities, meatmeal must be purchased as a high protein supplement to the grain ration. It is essential to feed such a supplement in order to reduce the protein ratio of wheat, which is 7.5, to about 4.5, which is that required by growing pigs. The protein ratio of meatmeal is about 1 : 0.62, and for some time this food

has been the cheapest form of protein on the West Australian market. This supplement is useful in the ration of pigs of all ages, and, even although not required, is sometimes added in small quantities as a relish to the ration. It is a useful supplement to the ration of the brood sow, as it gives strength to the piglets in utero and is an insurance against the habit of devouring the newly-born litter. Usually about 5 to 10 per cent. of the meal ration may be made up of meatmeal, the proportion depending on the age of the pigs being fed. (See Table 2.)

Mineral Supplements.

Owing to the rapidity of its growth, no domestic animal shows the results of mineral deficiency so rapidly as the pig. There is a heavy call on bone-building constituents, particularly calcium and phosphorus. This deficiency is likely to occur very quickly where pigs are sty fed and have not access to earth. Where lucerne or clover grazing is available, or these crops are fed as good quality hay, there is not likely to be a deficiency of either of these minerals. Charcoal is relished by pigs and has absorbent and digestive qualities which keep the organs in a healthy condition. From time to time also, particularly with sty fed pigs, a little salt should be included in the ration.

Where meatmeal is being fed, there is not likely to be a deficiency of phosphorus, but as the other portion of the ration will be mainly wheat or a similar grain, there may be a deficiency of lime, which can be supplied by an addition of 1 to 2 per cent. of ground limestone or bonemeal to the ration.

RELATIVE FOOD VALUES OF CONCENTRATES.

Perth, December, 1936.

Foodstuff.	Cost.	Cost per 100 lb.	Starch Equivalent per 100 lb.	Digestible Protein per 100 lb.	Cost per 1 lb. Starch Equivalent.	Cost per 1 lb. Digestible Protein.
		s. d.	lb.	lb.	d.	d.
Wheat	5s. 6d. per bushel of 60 lb.	9 2	83	10.2	1.33	10.78
Oats	3s. 2d. per bushel of 40 lb.	7 11	71	8.0	1.34	11.88
Bran	£7 10s. per ton ...	7 6	54	14.6	1.67	6.16
Pollard	£7 10s. per ton ...	7 6	80	15.5	1.12	5.81
Linseed Meal ...	£12 10s. per ton ...	12 6	80	29.0	1.88	5.17
Meat Meal (W.A.)	13s. per 100 lb. ...	13 0	100	65.0	1.56	2.40
Peas	Unobtainable ...	...	...	...	...	...
Young Subterranean Clover Pasture *	20s. per ton ...	1 0	65	19.0	0.19	0.63
Subterranean Clover Silage	10s. per ton ...	0 6	43	9.4	0.14	0.64

* Dry matter.

The above table shows that for the supply of energy or fat-forming foods, among the grains, wheat, oats and pollard are approximately the same value, pollard being slightly cheaper than the other two.

The cheapest source of protein or flesh-forming food, apart from pasture and silage, is meatmeal. Protein in meatmeal is approximately half the cost of that contained in linseed meal.

No purchased concentrate, however, can compete with young clover pasture or clover silage in economy of production.

FEEDING PIGS IN THE WHEAT BELT.

The basic foods which will be available in dry areas are wheat, barley, and oats, depending on the district in which pigs have to be fed. Probably no single fact in stock feeding has been more clearly demonstrated by numerous feeding trials than that maize, wheat, and other cereal grains alone give exceedingly poor results when fed to growing and fattening pigs.

The following table summarises the results of seven trials in which maize alone was fed to young pigs, averaging 69 lb. in weight, in comparison with another group of pigs where meatmeal was added to the maize ration. The results also are given for 15 similar comparisons of *maize alone versus maize and meatmeal* for older pigs averaging 184 lbs. in weight when the experiment began.

TABLE 3.

MAIZE ALONE *VERSUS* MAIZE AND MEATMEAL.

Average Ration.	Length of Trial.	Daily Gain.	Feed for 100 lbs. Gain.	
			Maize.	Meatmeal.
With Young Pigs—	days.	lbs.	lbs.	lbs.
(1) Maize alone, 3.5 lbs.	122	0.59	642	...
(2) Maize, 4.4 lbs. ... ... Meatmeal, 0.48 lbs.	122	1.18	387	42
With Older Pigs—				
(1) Maize alone, 5.7 lbs.	69	1.03	617	...
(2) Maize, 6.1 lbs. ... ... Meatmeal, 0.67 lbs.	66	1.59	400	43

It will be seen that the younger pigs gained only 0.59 lb. per head daily and required 642 lb. maize for each 100 lb. gain. Where meatmeal was added the gains were practically double, and only 387 lb. maize were consumed for each 100 lb. gain.

Similar results were obtained with the older pigs, although, as might be expected, this group did not show the effect of the omission of the meatmeal so seriously as in the younger pigs.

In numerous experiments where wheat and maize have been fed in comparison, it has been shown that their value is similar, wheat being slightly superior.

From the above, the folly of feeding such an unbalanced ration as maize or wheat alone will be realised, and yet there is ample evidence at various sales that pigs are being fed on such a ration, which makes the carcases short, stumpy, and very fat.

Some roughage also is necessary which, in the winter time, can be supplied by grazing, and, in the summer time, from the use of good cereal chaff or meadow hay, mixing about 10 per cent. with the grain ration.

Shrunken wheat that has been injured by drought or frost before maturity can be economically fed to pigs, although it may be unsuited for milling and would realise a low price. Such wheat is usually richer in protein than wheat of good milling quality, and, if not excessively immature before the check in growth occurs, may be equal in feeding value to sound wheat.

Inquiry is sometimes received regarding the value of pickled wheat for feeding to pigs. This depends on the chemical used for pickling. In the case of Formalin, the wheat should not be fed to stock. In the case of Copper Carbonate, provided the wheat has been thoroughly soaked in two changes of water, there will be little danger from feeding to pigs, as the Carbonate is dissolved in the water.

Wheat or other grains always should be ground or crushed before feeding, the saving in the case of wheat being from 16 per cent. to 22 per cent. Soaking wheat is a poor substitute for grinding, as it makes little saving over feeding the grain dry.

Barley may be regarded as approximately the same value as wheat for feeding to pigs and should be treated in a similar manner.

Good feed oats, when used to replace barley or wheat, should be regarded as worth about three-fourths the value of these two grains.

In feeding trials in America and Great Britain, it has been found that approximately 4.4 lb. of wheat is required to produce 1 lb. of bacon. Feeding trials in Queensland and at "Tipperary," York, Western Australia, have shown that a lesser quantity than this is required, namely, from 3.6 to 3.9 lbs. to produce 1 lb. of bacon. This is due probably to the warmer climatic conditions which would reduce the food required for maintenance as compared with that in colder countries.

The following ration is one that has given good results and is recommended for use in wheat producing areas:—

Crushed Wheat or Barley	80 parts.
Meatmeal—60 per cent. Protein	9 „
Good Oaten Chaff	10 „
Ground Limestone	1 „

Pigs should be fed as much of the above ration as they will "clean up" in about 10 to 15 minutes twice per day, which, under ordinary circumstances, will be found to approximate 1 lb. per day for each month of age of the pig.

In dry areas it is essential that ample shade and water should be available always. It is not necessary to erect expensive shelters, a cheap shelter, being that illustrated, may be made of posts and wire netting about four feet from the ground on which 9 to 12 inches of straw has been placed. This may be destroyed at the end of the season if thought fit.

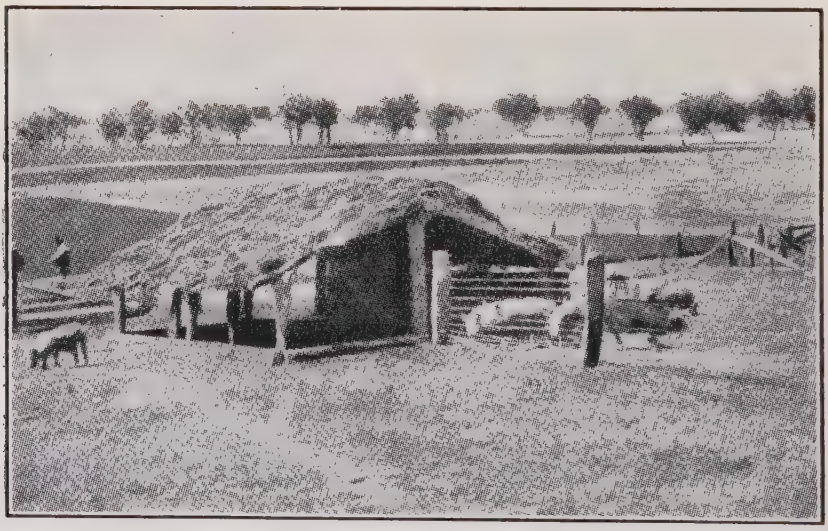


Fig. 17.

Cheap shelter suitable for wheat belt conditions. Water troughs also could be covered in this manner.

PORK OR BACON.

The most profitable period for the feeding of pigs is from the time they are about 80 lb. live weight up to bacon stage, i.e., about 170 lb. live weight.

In order that pork production should be profitable, it is necessary that a higher price per lb. should be received for this carcase. The difference between pork and bacon prices—in order for pork to be profitable—will vary with the price of grain. As a guide: With wheat at 3s. per bushel, pork should be 1½d. per lb. more than bacon to be profitable. With wheat at 3s. 6d. per bushel, pork should be 1¼d. more. With wheat at 4s. per bushel, pork should be at least 1d. per lb. more.

It is only for short periods each year on the local market that these differential prices obtain. During 1934-35 this profitable difference in favour of pork only existed during nine weeks of the 52, and six of these weeks were immediately prior to Christmas.

Generally speaking, farmers situated any distance from the metropolitan area would be well advised to aim at bacon production rather than pork.

VALUE OF WHEAT FOR BACON PRODUCTION.

The following table shows the value of wheat at varying prices when used for feeding pigs. The ration used as a basis of the calculation is that recommended above.

Table 4.

EFFECT OF BACON PRICES ON VALUE OF WHEAT FOR FATTENING PIGS.

Bacon Prices, per lb.	Value of Carcase, 120 lbs.	Net Return after deducting Cost all Feeds except Wheat.	Value of Wheat per bush.
s. d.	s. d.	s. d.	s. d.
0 7	70 0	60 4	7 6½
0 6½	65 0	55 4	6 11
0 6	60 0	50 4	6 3½
0 5½	55 0	45 4	5 8
0 5	50 0	40 4	5 0½
0 4½	45 0	35 4	4 5
0 4	40 0	30 4	3 9½

Feeding trials in South Australia during 1939 with barley as the grain concentrate and fed with meatmeal confirmed the above values first published in 1936.

FEEDING PIGS IN THE DAIRYING DISTRICTS.

The by-products on dairy farms, which are difficult to utilise unless fed to pigs, will consist of skim milk and—where farmers are close to factories—butter milk and whey. These products are specially valuable by reason of the character of the protein which they contain and also its high digestibility, which is practically 100 per cent. These products are also rich in mineral matter, especially in lime and phosphorus, which are the chief minerals forming the skeleton.

It has been claimed that fat soluble vitamin has been removed from skim milk, butter milk and whey, and for this reason, if any of these by-products are fed with a grain low in this vitamin, such as white maize, it may result in poor returns. This deficiency, however, is cheaply supplied by making lucerne or clover available to the pigs either in the form of grazing or as hay.

Fig. 18.

A crop of maize grown for grain, the pigs being allowed to harvest the grain from the cobs themselves. An economical method of feeding grain with skim milk.

In arriving at a feeding value for skim milk, this food should be compared with the most efficient commercial substitute, which is meatmeal. No progressive farmer would attempt to feed pigs on such an inefficient ration as grain alone when they are not on clover pasture.

The following table shows the comparative value of skim milk and meatmeal as a supplement to maize for fattening pigs, and, as mentioned before, wheat or barley is comparable to maize, but slightly superior for this purpose.

Table 5.

SKIM MILK *VERSUS* MEATMEAL AS A SUPPLEMENT TO MAIZE.

Average Ration.	Daily Gain	Feed for 100 lbs. Gain.		
		Maize.	Skim Milk.	Meatmeal.
	lbs.	lbs.	lbs.	lbs.
(1) Skim milk, 7.1 lbs. ... ... Maize, 4.6 lbs.	1.36	346	535	...
(2) Meatmeat, 0.47 lbs. ... ... Maize, 4.90 lbs.	1.24	404	...	39

These trials, which are the average of 12, show that skim milk is slightly superior to meatmeal for supplementing grain.

For feeding to young pigs before and soon after weaning, skim milk is best if fed fresh, although even for young pigs, as long as souring is effected under sanitary conditions, results are satisfactory. If, however, sour milk must be used, it always should be fed sour. Feeding sweet milk at one period and sour at the next is apt to cause scours.

MONEY VALUE OF SKIM MILK.

Feeding trials have shown that 100 lb. of skim milk can replace in the ration approximately 11 lb. of wheat and 7.25 lb. of meatmeal, and its money value, therefore, with wheat and meatmeal at various prices, may be readily computed. Butter milk also may be regarded as equal in feeding value to skim milk.

In considering these values, however, it should be borne in mind that they are only true when no more milk is fed than is needed to balance the ration. If greater quantities of skim milk are provided than necessary for this purpose, the extra amount consumed is converted into fat and not into lean meat, the nitrogenous portion being lost in the excreta. It is, therefore, uneconomic to feed skim milk or butter milk alone.

Table 6.

MONEY VALUE OF SKIM MILK OR BUTTER MILK PER GALLON FOR PIGS.

Value of 1 gallon skim milk or butter milk—	Price of Wheat per Bushel.					
	3s. 0d.	3s. 6d.	4s. 0d.	4s. 6d.	5s. 0d.	5s. 6d.
	d.	d.	d.	d.	d.	d.
With meatmeal at £12 per short ton	1.70	1.81	1.92	2.03	2.14	2.25
„ „ „ £13 „ „ „	1.79	1.90	2.01	2.12	2.23	2.34
„ „ „ £14 „ „ „	1.88	1.99	2.10	2.21	2.32	2.43
„ „ „ £15 „ „ „	1.96	2.07	2.18	2.29	2.40	2.51
„ „ „ £16 „ „ „	2.05	2.16	2.27	2.38	2.49	2.60
„ „ „ £17 „ „ „	2.14	2.25	2.36	2.47	2.58	2.69

Meatmeal, £14 per ton; oaten chaff, £3 per ton on farm.

When the supply of skim milk is low, it is not necessary to feed more than 3 to 4 lb. for every 1 lb. of grain consumed, but, under average conditions, from 6 to 10 lb. of skim milk for every 1 lb. of grain will give satisfactory results, the greater quantity of milk being used when feeding the younger pigs.

WHEY.

Whey is relatively low in protein, as the casein of the milk is removed in cheese-making. Because of this, its nutritive ratio is 1 : 6.8 in comparison with 1 : 1.5 in the case of skim milk. Owing to this low content of protein whey is sometimes overlooked as a supplement to cereal grains.

Feeding trials, however, have shown that whey is of considerable value when fed with certain grains for fattening pigs. When fed with barley, surprising results have been obtained where about 3 lb. of whey per lb. of barley forms the ration, gains of as much as 2.2 lb. per day being obtained. This was in spite of the fact that the ration had a nutritive ratio of 1 : 7.4. These results apparently are due to the fact that, while whey is low in protein, what it does contain—which is chiefly milk albumin—is of excellent quality to serve as a supplement to the proteins of cereals.

These pigs were approximately 125 lb. live weight when feeding commenced. With younger pigs it is found necessary to add some protein rich food, such as meatmeal, or linseed meal, in order to balance the ration. About 1 lb. of meatmeal or 3 lb. of linseed meal should be added to the ration for every 10 gallons of whey.

Fig. 19.

Skim Milk made the Difference.

These two pigs are of the same age, from the same litter, were both weaned from mother at six weeks old, and were both fed as much ground oats, ground barley, and ground corn as they would eat. They were kept in the same feed barns and were cared for by the same persons, the only difference being that the larger one received milk and the smaller one had no milk. The pig receiving no milk is not only smaller but he has a poor coat, has scurvy, and is in every way a poor specimen.

SUPPLEMENTS TO SKIM MILK IN DAIRYING DISTRICTS.

In these districts one of the greatest advantages over the dry areas is the ability to supply good grazing or green fodder crops during the greater portion of the year. Where lucerne or clover can be supplied in the form of grazing, about 4 to 5 inches high, little else is required beyond skim milk in order to ensure rapid growth until about one month from bacon weight. Such pigs, however, if forwarded to the market without being "topped off" with some grain, do not dress out economically, and the quality of the fat is inferior. The pigs are described in the trade as being "soft." In order to overcome this, it is essential that grain in one form or another should be supplied. It is not necessary to confine the pigs to sties in order to do this, as the grain may be fed either by hand twice a day—usually at the same time as the skim milk—or self-feeders may be placed in the paddocks where the pigs to be "topped off" are grazing. It is uneconomical to self-feed the growing pigs or sows, so that several small pig paddocks are required for efficient management.

In order to obtain the best returns, an effort should be made to provide the grain from home-grown produce. Barley or peas can be grown successfully, and it should be possible in many areas for either maize or a mixture of maize and cow peas to be grown and allowed to ripen, so that pigs may be

"topped off" in the field (see Fig. 18). Where peas are being grown, as the nutritive ratio of peas is 1 : 2.6, it is uneconomical to feed alone or to graze peas. It generally will be found profitable to purchase wheat, barley, or pollard to be fed in conjunction with the peas, equal quantities of either with peas forming the ration with skim milk as before.

At certain times of the year potatoes may be available and would be suitable for feeding with peas, as potatoes are very low in protein, their ratio being wide. 1 : 11.

Four to 5 lb. of potatoes are the equivalent of 1 lb. of grain.

A mixture such as maize and cow peas, if sown early in the summer, should ripen within 4 to 5 months and may then be harvested by the pigs themselves, from which a complete ration could be obtained.

The importance of grazing in conjunction with feeding in the dairying districts, however, should not be overlooked, as the saving in grain, where good grazing is available, varies from 10 to 15 per cent., and the supply of grain is the expensive portion of the ration in these districts.

Fig. 20.

Cow Peas and Maize, S. F. Russell, "Wendowie," Serpentine.

SELF-FEEDING.

There is now no doubt that permitting pigs to feed themselves from supplies of rations, either separately or ready mixed, is not only economical but ensures a great saving in labour. The system of self-feeding gives excellent results with *growing fattening* pigs, or with old sows which are to be fattened.

The self-feeder should not be used when rapid gains are not required, or for growing pigs for the breeding herd, or for pregnant sows, unless some bulky food such as clover chaff or good oaten chaff is mixed with the grain. For such pigs, however, hand-feeding would be preferable.

The following table shows the results of 17 trials of hand-feeding pigs in comparison with self-feeding. It will be seen that the self-fed pigs grow a little more rapidly than the hand-fed pigs and consume rather less of the ration for each 100 lb. gain in weight. In these trials the pigs had no pasture available, but similar results were obtained in other trials where pasture was available.

TABLE 7.

SELF-FEEDING *VERSUS* HAND-FEEDING.

Without Pasture. 314 Pigs—Average weight, 86 lbs.

	Daily Gain.	Feed for 100 lbs. Gain.		
		Maize.	Meatmeal.	Total.
	lbs.	lbs.	lbs.	lbs.
(1) Self-Fed	1.58	359	56	415
(2) Hand-Fed, twice per day all that they would clean up	1.42	356	68	424

Similar results were obtained where pasture was available.

It is immaterial whether the ration be mixed and all fed through the one self-feeder, or whether a number of self-feeders are used, each containing a separate ingredient of the ration. The pigs apparently will eat the various proportions as required in order to give maximum growth. It is usual, however, to mix the ration where more than one grain is being used, and also the meatmeal may be mixed with the grain ration without any physical inconvenience in feeding.

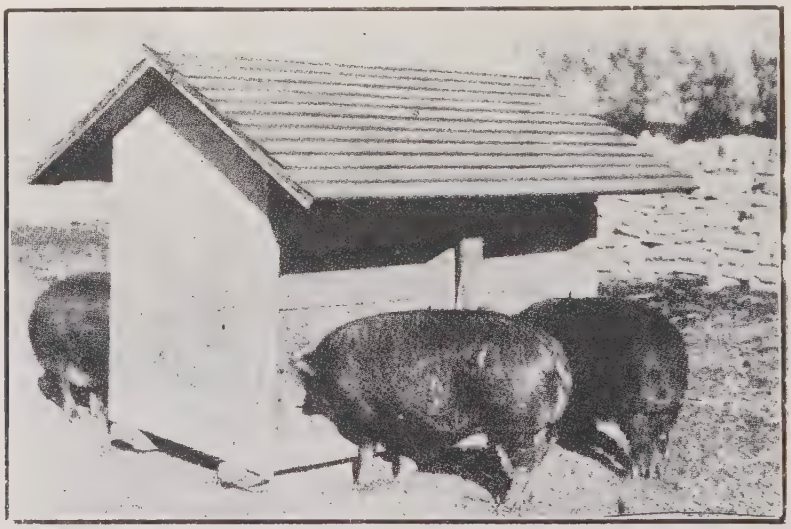


Fig. 21.
The Self-Feeder working.

It is necessary to inspect the feeder at frequent intervals to see that the troughs are clean and that a free flow of food is available from the hopper. The feeder should be located on a dry area of land and, if possible, mounted on skids so that it can be removed to a clean place when necessary.

The following are details of a self-feeder which has given excellent results in Canada and Australia and is suitable for feeding from 15 to 20 pigs.

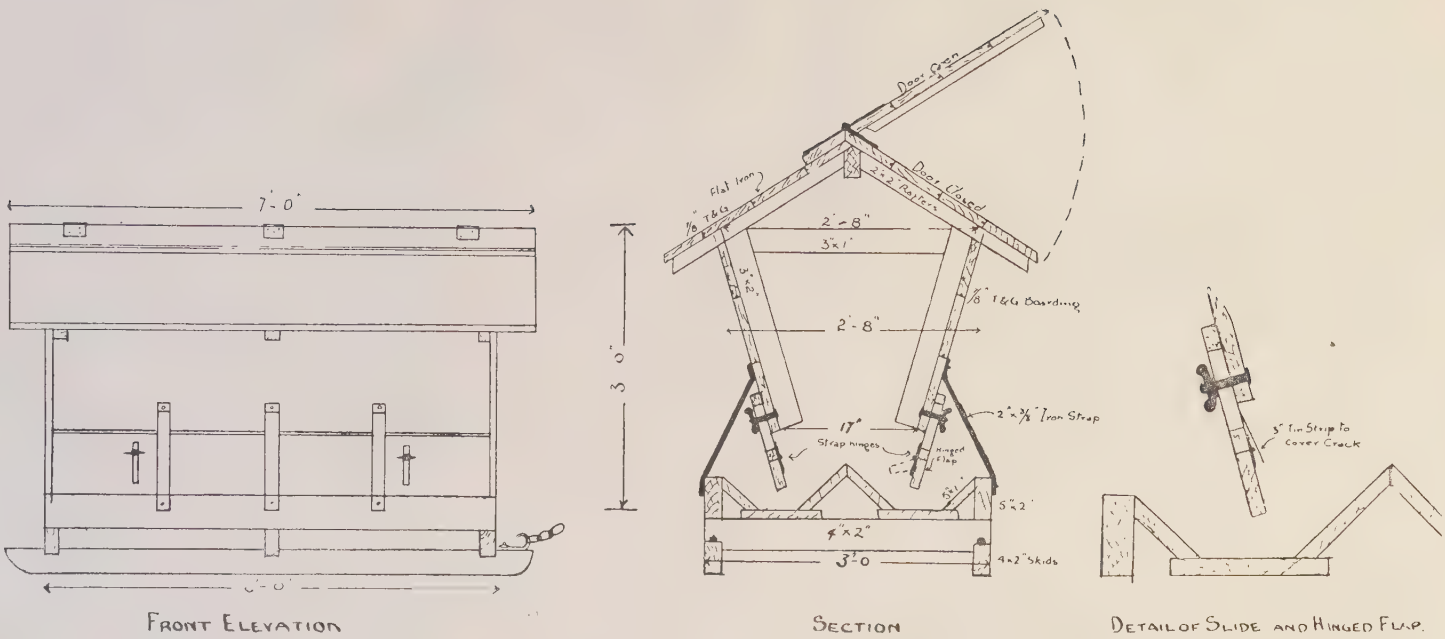


Fig. 22.

Details of Self-Feeder described on page 502.

CONSTRUCTION OF SELF-FEEDER.

1. *The Feed Trough.*

The self-feeder rests on two 4in. x 2in. skids provided with two strong flat iron draught lugs, which render it portable.

Three 4in. x 2in. bearers are then notched over the skids. On top of these bearers the feed trough is formed, the bottom being 10in. x 1in., and the sides 5in. x 2in. on edge bolted to bearers with ⅜in. bolts through the skids and bearers. Two pieces of 8in. x 1in. wood placed at 45 degrees form the centre or back of both troughs, and two pieces of 5in. x 1in. wood placed at 45 degrees from the 5in. x 2in. side-pieces to the bottom board complete the feed trough.

2. *The Bin.*

The bin, or hopper, is constructed of wood. The frame is made of 3in. x 2in. uprights with 3in. x 1in. across the top; rafters of 2in. x 2in. and 4in. x 2in. ridge. The top is sheathed with 6in. x ⅞in. tongue and grooved boards; one side of the top acts as the door, which is composed of 6in. x ⅞in. tongue and grooved boards with two 6in. x 1in. ledges. The door and top are covered with flat iron; hinge door with three strap hinges.

The top should project well over the trough, so that water will not drip into it. The sides and end of the bin should be sheathed with 6in. x ⅞in. tongue and grooved boards. The bin is supported by 2in. x ⅜in. iron straps bolted to trough and to bin.

The slide and hinged flap are regulated with a slot and bolt and screw; the bottom of the slide is hinged with strap hinges. The slide is 8in. x 1in. wood, the flat 4in. x 1in. wood, with a strip of tin or light iron 3in. wide to cover the crack.

The whole structure measures 6 feet long by 3 feet wide, the eaves projecting 6 inches all round.

Thinning as Related to the Acquisition of Apples and Pears.

H. R. Powell, Superintendent of Horticulture.

The announcement by the Assistant Minister for Commerce, Mr. H. L. Anthony, as set out hereunder, that apples and pears of prescribed varieties and grades, with size limitations, will be acquired under the National Security (Apple and Pear Acquisition) Regulations, is of particular interest to fruit growers in this State.

Accepting the viewpoint that pre-war incomes may be seriously reduced by restrictions of exports imposed by the shortage of shipping space, it is necessary to take the view that some steps can be taken to alleviate the position by the grower himself. I mean the grower, by judicious thinning, cultivation and orchard hygiene, can do much to ensure, with anything like favourable weather conditions, that the bulk of his crop will be acquired.

Last season, assessments were made in January by officers of this branch and in cases where the fruit was unthinned and of poor size (mostly Yates and Doughertys), the assessment was deferred until the required attention was given. Unfortunately, weather conditions were so severe that many hundreds of cases of fruit could not be marketed on account of being under size. This loss was most noticeable on those orchards where adequate thinning operations had not been carried out.

This season the "assessments" or "appraisements" will in all probability be carried out in February for the mid-season varieties and it seems certain that fruit not coming up to the minimum size requirements will be excluded from the assessment. This will mean a heavy loss to those growers who could have done much to prevent it.

It must be remembered that thinning is not an additional burden on orchard costs, as it means that the fruit thinned from the trees is handled only once before it is dropped on the ground. If it is left on the trees, however, the small fruits are a loss to the grower, a burden for the trees, and they will have to be ultimately removed from the trees, particularly in those districts where Fruit Fly is prevalent.

A study of the Schedule shows how unprofitable it will be to grow apples of small sizes, particularly Yates, Doughertys and Cox's Orange Pippin. "Extra Fancy" and "Fancy" grades of these varieties, minimum size 2¼ in., quality for advances of 3s. per bushel, whilst apples of the same grade of 2⅛ in. size, only qualify for advances of 2s. per bushel, and "Good" grade of 2⅛ in. size, will not qualify at all for advances.

The minimum size for the other varieties of apples is 2¼ in., except that in (b) group 2 of the schedule it is 2½ in. for varieties such as Ballarats, Prince Alfreds, etc.

ACQUISITION OF APPLES AND PEARS.

Information regarding the conditions under which advances will be made to growers on apples and pears of the 1940-41 crop which is to be acquired by the Commonwealth, has been made available by the Assistant Minister for Commerce (Mr. H. L. Anthony).

Details showing the classification of the varieties of apples and pears into groups, the prescribed grades and sizes qualifying for compensation advances, and the rates of the advances for fruit in this State are set out below:—

APPLE AND PEAR ACQUISITION—1940-41 CROP.

APPLES—Varieties, Qualifying Sizes and Rates of Advance.

Western Australia.

Group 1—*Varieties*—

(a) Delicious	Democrat	Granny Smith
Jonathan	Gravenstein	Legana
Beauty of Bath	Williams Seedling	Willie Sharp
Carrington	Kirk's Seedling	Cowell's Red
Cleopatra	Peasgood	Twenty Ounce
Mobb's Royal	Lady Daly	Trivett
Lord Nelson	Warner's King	

X.F. and Fancy	Good.
2¼ in. minimum,	2¼ in. minimum,
3s.	2s.

Group 1—*Varieties (continued)*—

(b) Cox's Orange Pippin	Crofton.	Dougherty.	Yates.
X.F. and Fancy 2¼ in. minimum, 3s.	X.F. and Fancy. 2⅛ minimum, 2s.	Good. 2¼ in. minimum, 2s.	Good. 2⅛ in. minimum, not qualifying.

Group 2—*Varieties*—

(a) Australian Beauty	Scarlet	Tasman's Pride
Geeveston Fanny	Golden Delicious	King Cole
Duke of Clarence	Nickajack	Rokewood
Stone Pippin	Sturmer	Dunns
Rome Beauty	McIntosh Red	Statesman
Stayman	Worcester	
X.F. and Fancy 2¼ in. minimum, 2s.	Good. 2¼ in. minimum, 1s.	
(b) French Crab	Ballarat (Stewart's Seedling)	Alfriston
London Pippin	Prince Alfred	
X.F. and Fancy. 2½ in. minimum, 2s.	Good. 2½ in. minimum, 1s.	

Group 3—*Varieties*—

Alexander	Ben Davis	Pomme de Neige
Ranelagh	Pioneer	Schroeder
Wellington Pippin	Yapeen	Coleman
Auradell	Crow Egg	Spitzenberg
King David	King Pippin	Newton Pippin
Ribston Pippin	Strawberry Pippin	Buncombe
X.F. and Fancy 2¼ in. minimum, 1s.	Good. Not qualifying.	

Any other varieties or sizes required for marketing will be compensated on a basis of quality and size to be determined.

A schedule for pears in Western Australia is not included as the grouping has not yet been finally determined.

Compensation in each group is provided for fruit of "Extra Fancy" and "Fancy" quality. Fruit of "Good" grade in a particular group will rank for compensation on the basis of "Extra Fancy" or "Fancy" grade in the next lower group.

The acquisition will relate only to pears for sale as fresh fruit; quantities delivered to canneries for processing will not be acquired.

Compensation will be paid to growers of fruit actually delivered to the order of the Minister or of the Marketing Committee. Fruit produced suitable for delivery if not required, will be compensated subject to the approval of the Minister.

Growers will be required to harvest their fruit and provide containers for harvesting where such are distinct from containers for storage or sale. It will also be necessary for growers to transport such fruit and containers either to the gate of the property on which the fruit is grown, or to such other point closer to the trees as may be directed.

As to any further services and materials which growers may be directed to provide in effecting deliveries, the costs involved will be recouped at rates to be determined.

To ensure that usual sources of finance for crop production and marketing are not withdrawn through undue uncertainty as to payment, arrangements will be made for the payment to merchants from advances, or other amounts due to growers from time to time, amounts claimed by merchants and authorised by growers. It is intended, however, that such payments to merchants will be restricted to amounts advanced by merchants and declared as having been for either production costs or delivery or marketing costs of the crop of apples and pears produced between 1st August, 1940 and 31st July, 1941.

Dairy Premises.

G. K. Baron-Hay, Superintendent of Dairying.

The following notes and diagrams are intended to convey to those dairy farmers desirous of constructing dairy premises the minimum requirements necessary for compliance with conditions for the supply of cream to Dairy Produce Factories, and plans for buildings considered suitable to West Australian conditions.

It is pointed out that the plans submitted are not laid down as those which must be adhered to, but are intended to act as a guide to those farmers desiring to erect new premises or who may be required by Inspectors to alter the structure of existing buildings. Because of this, specifications are not attached to these plans, as such can be drawn out by any firm supplying the material which it is intended should be used in the construction of the buildings, and in very few instances do farmers build premises exactly according to plans and specifications, as their requirements and the lay-out of the surroundings may not be convenient in standard plans.

Whatever plan is adopted ultimately, there are certain principles to which the owner must adhere in order to conform with the regulations and to provide for the production of milk and cream under hygienic conditions.

Climatic Influences.

In the wetter regions of the State, it is advisable to construct buildings of materials which will withstand the wet winter so as to avoid the necessity of replacements for many years, and in this connection galvanised iron has been found most suitable, although jarrah—provided this is painted or treated periodically—will withstand climatic conditions for a considerable period. In wet periods, muddy yards are often a cause for contamination, and, during the summer months, dust—particularly from the assembly yard—is undesirable, as both have an adverse influence on the quality of the milk and cream produced.

In constructing the yards, therefore, the direction of the prevailing winds should be borne in mind, and the separator room and milk room should be protected as much as possible from dust or odours which are likely to occur in the yards or milking shed.

The attached lay-out of dairy premises for several types of bails indicates the essential items which should be borne in mind.

Because of the winter weather conditions, it generally will be found most suitable if milking sheds face east or south, the weather coming from the west and north during winter months. In the milking bails an endeavour should be made to aim at protection from prevailing winds.

Dusty Walls and Ceilings.

The interior surfaces of the walls and ceilings of the separator and cream storage room should be kept clean and free from dust which is laden with undesirable germ life.

Dust can be removed from the walls and ceilings either by water from a hose or by means of a damp cloth or mop.

Protection of Milk and Cream against Flies or Vermin.

All vessels in which milk or cream is held in storage should be covered by a wire metal gauze of a mesh so fine as to prevent contamination by flies or other vermin.

Precautions in Milk or Cream Room.

Calico, hessian, bagging, or paper, etc., must not be hung or fastened to the walls or ceiling of the cream room. Sour or skim milk or whey should not be kept in the cream room or its vicinity, and the utensils used to contain or convey them must be thoroughly washed and scalded immediately after use.

The Separator Room and Cream Room.

In regard to the separator room—whether erected adjoining the bails or a separate building—care should be taken to provide the most efficient system of ventilation by means of the prevailing winds.

As the separator room is a closed structure, the gable roof should be constructed so that the prevailing wind can blow through one end of the gable to the other, which would be at right angles to that selected for the bails. Therefore, the gables of the separator room usually will face north and south, in order to provide for better ventilation.

Lining the Walls.

The lining to the walls of the separator and cream storage room is optional, provided the internal surface of the walls is smooth and the material from which it is constructed free from projections, knots, etc. The provision of a double wall is preferred, as this provides for greater cooling. Where it is not intended to provide a double wall, then the uprights of the frame work of the cream room should be on the outside of the material used for the wall.

Size of Separator and Cream Room.

While the regulations provide that the cream room shall be at least six feet square and eight feet in height, in practice—except where small herds are handled—this will be found to be inadequate.

The following minimum sized rooms are recommended according to the various sized herds:—

	Size of Room.
20 Cows or more	12 ft. by 10 ft. by 10 ft. high.
10 to 20 Cows	8 ft. by 10 ft. by 10 ft. high.
10 Cows and under ..	6 ft. by 6 ft. by 8 ft. high.

For ventilation purposes such milk and cream storage rooms should have openings or air vents in at least two walls, the openings to be at least six inches wide at a height of six inches above the floor level and should face towards the direction from which the prevailing winds come. In order to prevent dust, such openings can be protected by a six inch hood or awning. For preference, the ceiling or lining of the roof should follow the contour of the roof, which should be provided at the apex with an air ventilator or cowl of eight inches diameter.

Diagram 1.

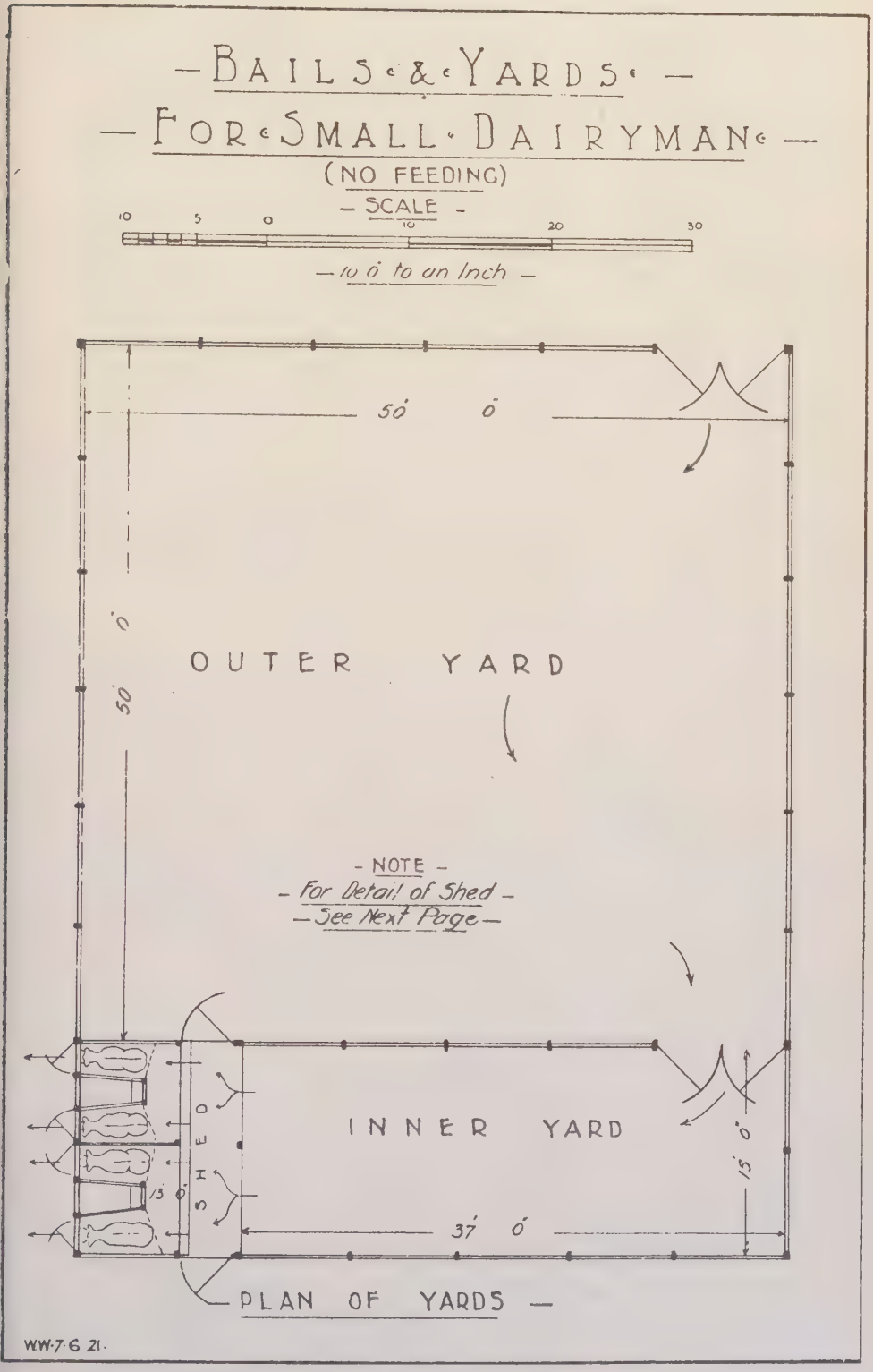
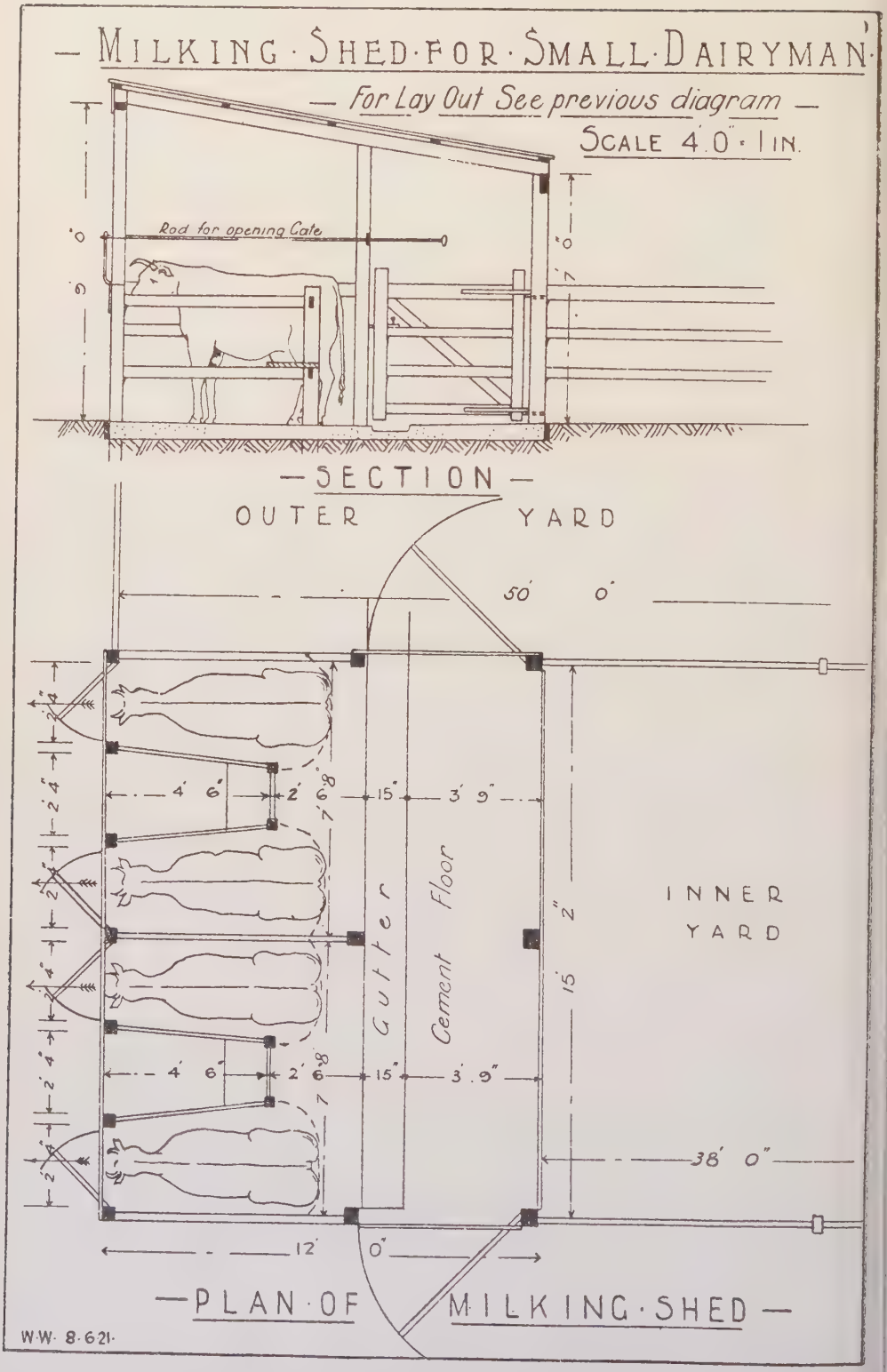

— BAILS & YARDS —
— FOR SMALL DAIRYMAN —
(NO FEEDING)
— SCALE —
10 5 0 10 20 30
— 10 ft. to an Inch —
50' 0"
50' 0"
OUTER YARD
— NOTE —
— For Detail of Shed —
— See Next Page —
SHED
13' 0"
INNER YARD
15' 0"
37' 0"
— PLAN OF YARDS —
WW-7-6 21.

Diagram 2.


— MILKING · SHED · FOR · SMALL · DAIRYMAN —
— For Lay Out See previous diagram —
SCALE 4'0" · 1 IN.
Rod for opening Gate
— SECTION —
OUTER YARD
50' 0"
4' 6"
2' 6"
1' 6"
1' 9"
15"
3' 9"
Gutter
Cement Floor
INNER YARD
15' 2"
38' 0"
12' 0"
— PLAN OF MILKING · SHED —
W·W· 8·621·

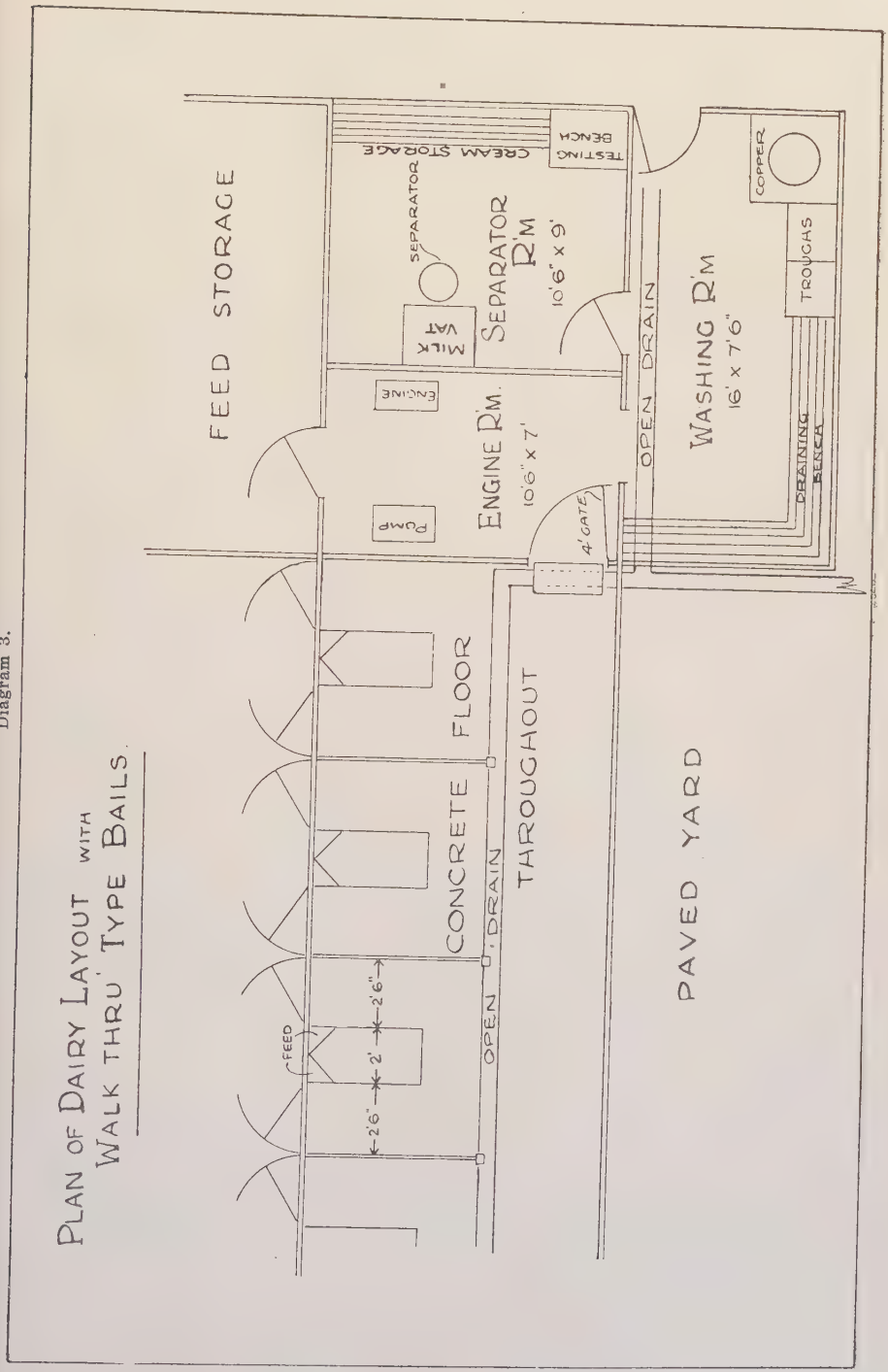
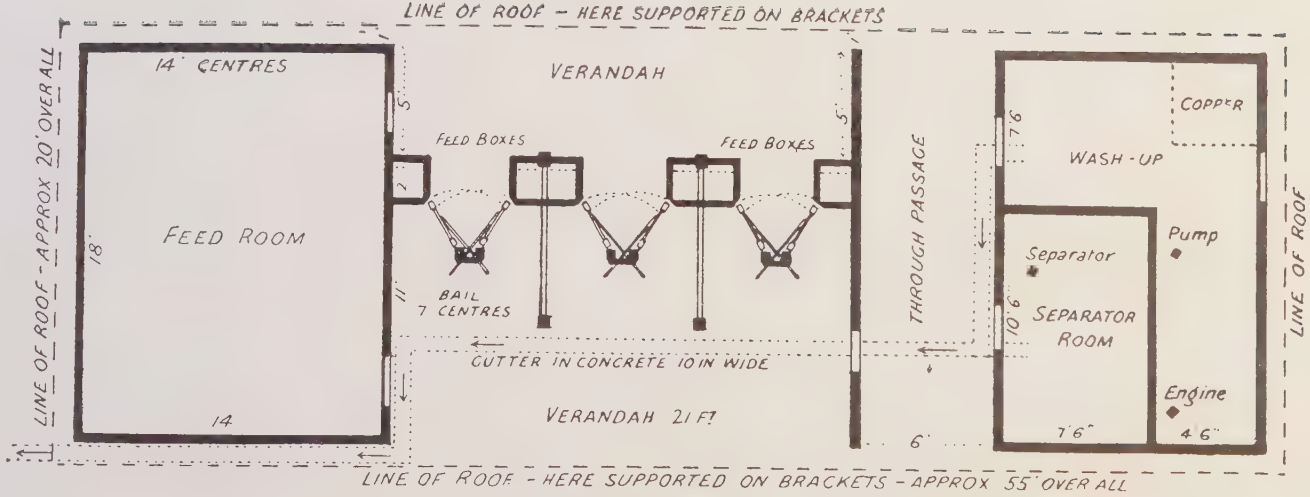
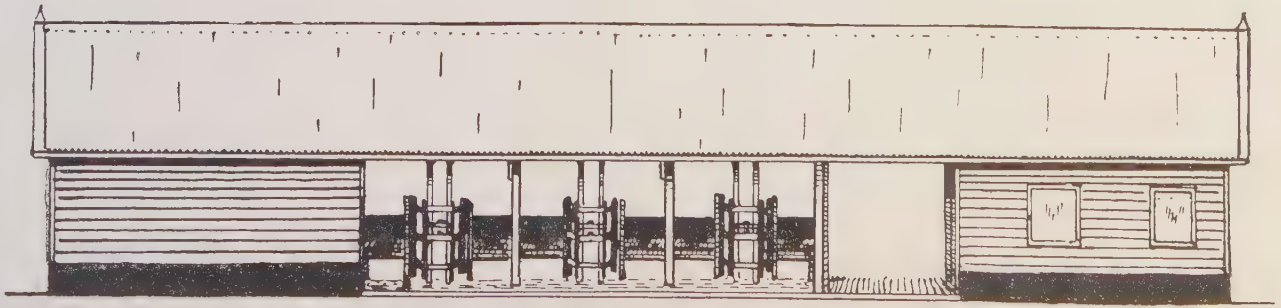

PLAN OF DAIRY LAYOUT WITH WALK THRU' TYPE BAILS.
FEED STORAGE
CREAM STORAGE
TESTING BENCH
SEPARATOR
MILK VAT
SEPARATOR R'M
10'6" x 9'
ENGINE
PUMP
ENGINE R'M.
10'6" x 7'
4' GATE
OPEN DRAIN
WASHING R'M
16' x 7'6"
COPPER
TROUGHS
DRAINING BENCH
CONCRETE FLOOR
THROUGHOUT
OPEN DRAIN
FEED
2'6"
2'
2'6"
PAVED YARD

Diagram 3.

Diagram 4.



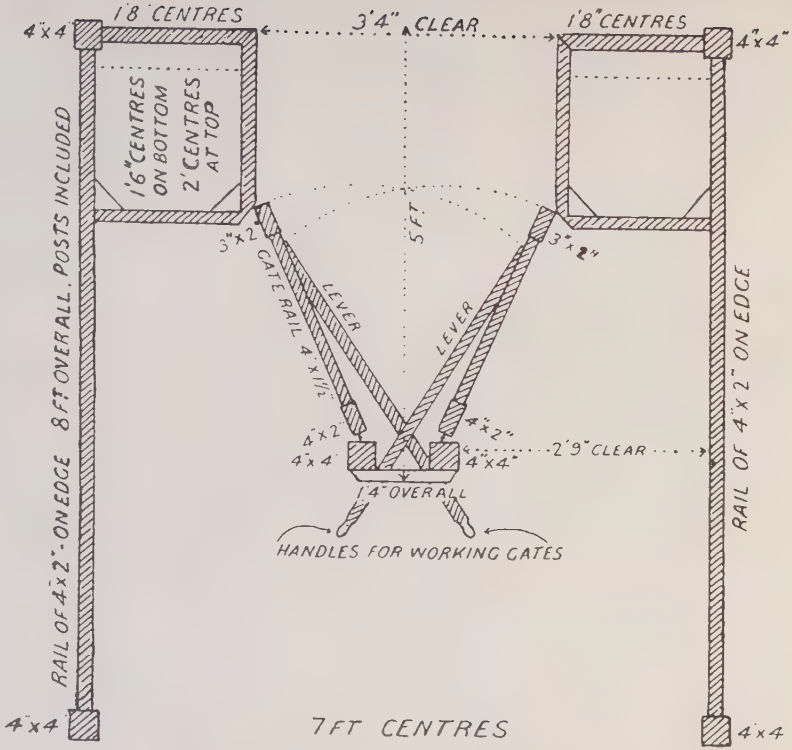
Ground Plan.



ELEVATION-VIEW FROM REAR OF BAILS

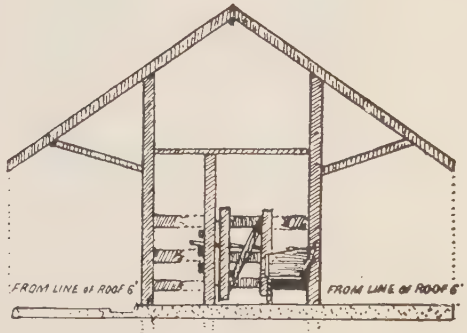
[Vict. J. of Agric.]

Diagram 5.



Detail Construction of Walk-through Bail.

END ELEVATION (DAIRY END)

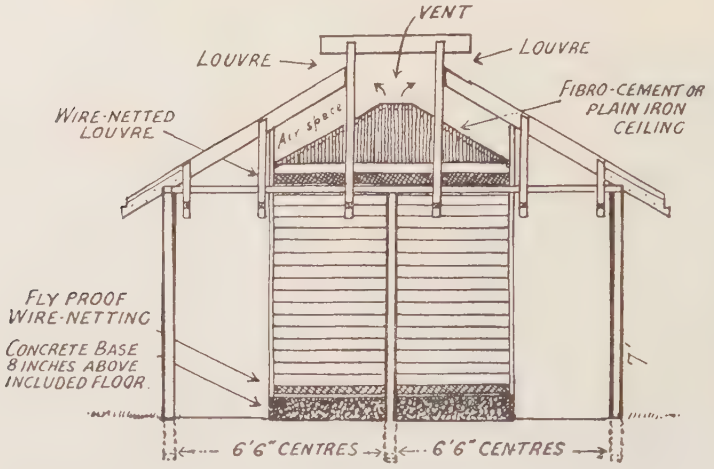


SHOWING BAIL ARRANGEMENT AND BRACKETED RAFTERS OVER SAME

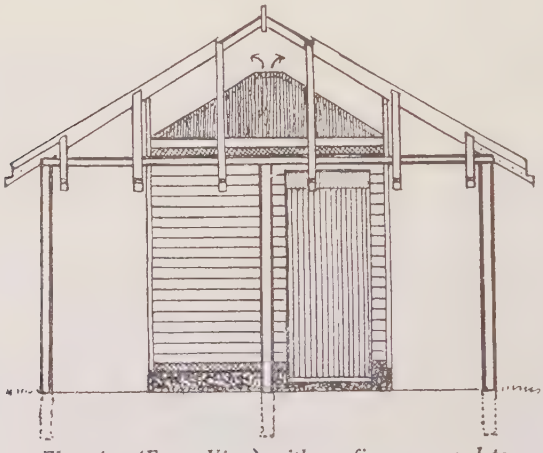
[Vict. J. of Agric.]

Diagram 6.

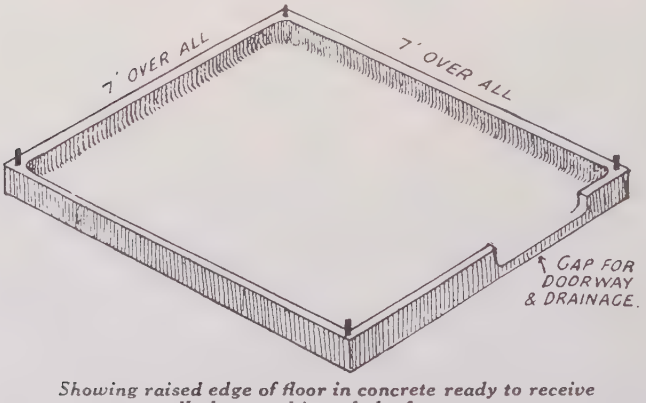
CREAM STORAGE ROOM.



Elevation (Side View) with roofing removed to snow construction.



Elevation (Front View) with roofing removed to show construction.



Showing raised edge of floor in concrete ready to receive wall plates and inset bolts for same.

[Vict. J. of Agric.]

Diagram 7.

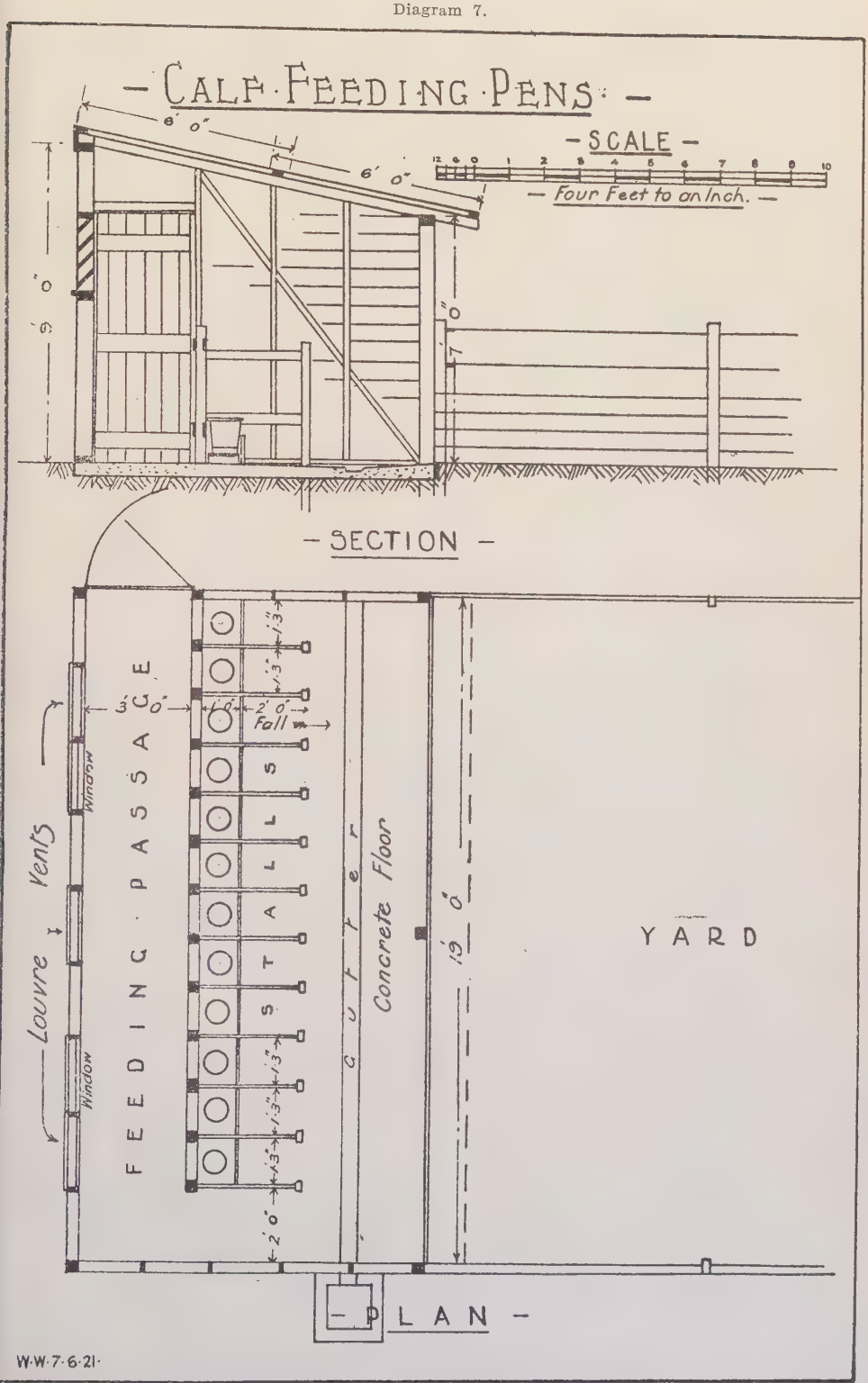
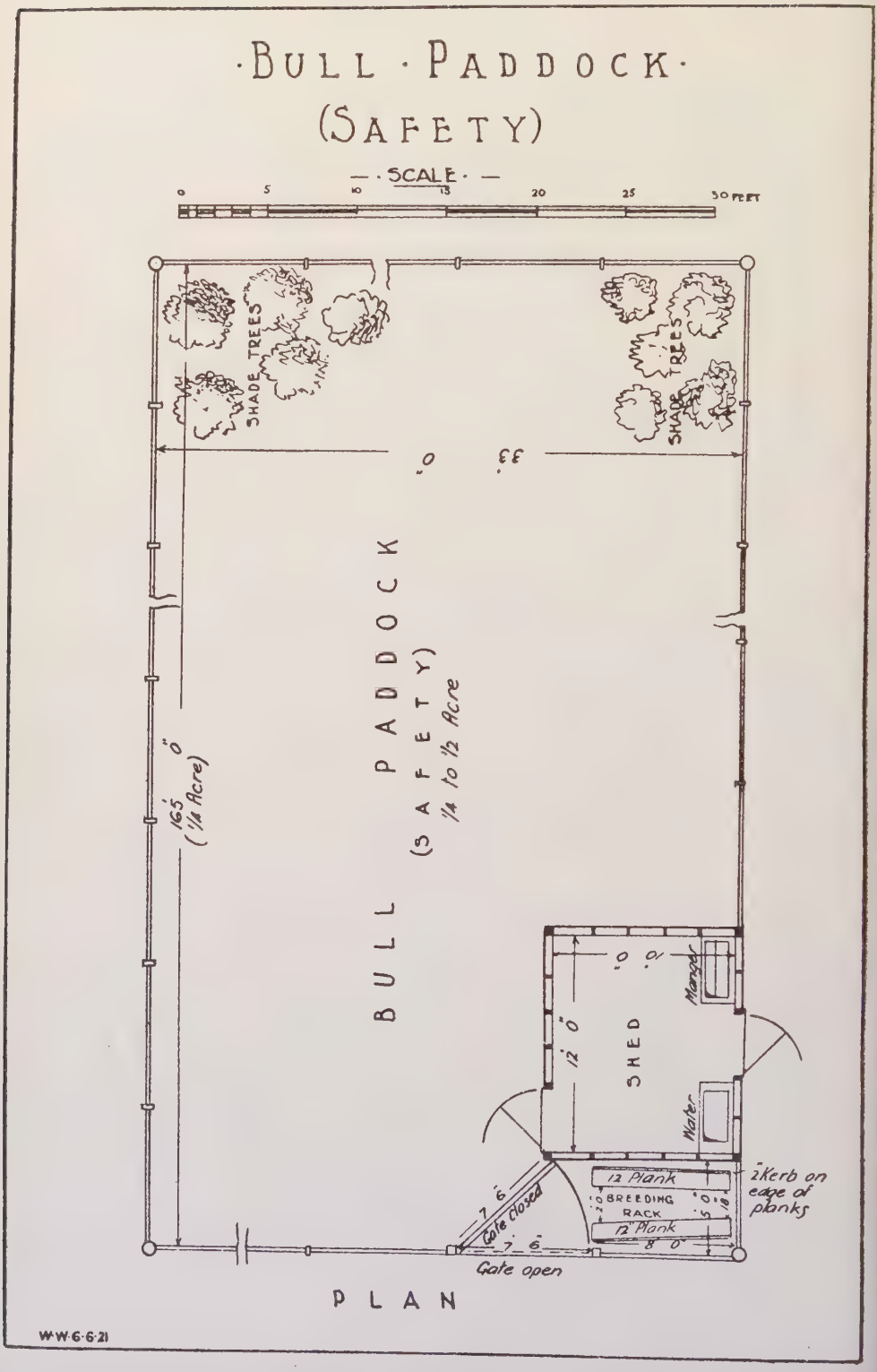

CALF FEEDING PENS
6' 0"
6' 0"
SCALE
Four Feet to an Inch.
5' 0"
7' 0"
SECTION
FEEDING PASSAGE
3' 0"
Louvre Vents
Window
Window
STALLS
2' 0"
Fall
Gutter
Concrete Floor
13' 0"
YARD
PLAN
W.W.7.6.21.

Diagram 8.


·BULL · PADDOCK·
(SAFETY)
— · SCALE · —
0 5 10 15 20 25 30 FEET
SHADE TREES
SHADE TREES
33' 0"
BULL PADDOCK
(SAFETY)
1/4 to 1/2 Acre
165' 0"
(1/4 Acre)
SHED
12' 0"
Manger
Water
12" Plank
BREEDING RACK
12" Plank
2' 0"
5' 0"
1' 8"
8' 0"
7' 6"
Gate closed
7' 6"
Gate open
2 Kerb on edge of planks
PLAN
WW·6·6·21

SUMMARY OF REQUIREMENTS.

1. Every stock yard and dairy premises used by any dairyman shall be properly drained.

2. Stables used for horses shall be disconnected from the dairy premises, that is, be under a separate roof and be at least 50 feet distant from the milking shed, milking room, or dairy.

3. No animals other than dairy cattle are to be kept or allowed in the milking shed.

4. No dung, offensive liquid, or noxious matter of any kind is to be permitted to accumulate or remain upon the premises.

Premises include stock yard around milking shed, and dung should be cleaned from the milking shed and the stock yard daily. A useful method—and one which ensures that this valuable material finds its way again on to fields—is to have a sled in a convenient position away from the milking shed, which is used for placing the manure upon daily. When this sled is conveniently full, it may be drawn out on to the paddocks and the manure rapidly spread. This prevents an accumulation which may require days of work to remove, and also provides that manure is returned quickly to the land without great loss of fertilising ingredients.

5. Fowl houses or enclosures for fowls are not permitted within 50 feet of any milking shed, milk room, or dairy.

6. No live poultry are permitted in the milking shed, and an Inspector may require same to be confined within approved enclosures.

7. No piggery or enclosure for pigs is permitted within 200 feet of any milking shed, milk room, or dairy. This also means that pigs are not permitted to roam on or around dairy premises.

8. No lavatories are permitted within 50 feet of a milking shed, milk room, or dairy.

9. The regulations require that cows must be milked in an approved milking shed which has a water-proof roof, and that the lowest part of this roof shall be not less than 7 feet above the floor level.

The practice of milking cows in the open, which is still followed by several of the older established farmers in the South-West, is to be discontinued.

10. The floor of the milking shed and also the dairy must be of non-absorbent materials on a solid foundation, evenly graded, the fall being away from the feeding trough and leading into open impervious drains running the full length of the shed and wide enough so as to be cleansed readily with a broom. The lowest portion of the floor shall not be less than three inches above the adjoining ground.

11. The drains or channels are to be carried at least 20 feet from the shed or dairy, or such further distance as may be advised by the Inspector to ensure adequate disposal of the drainage matter. Where necessary, these drains shall discharge into an impervious receptacle sufficient to hold one day's flow of drainage and which shall be emptied regularly.

12. The bin for mixing fodder is not permitted in the milking room.

13. Every dairy farmer must provide a room in which to store milk or cream, complying with the following provisions:—

(a) If room is detached, it must be at least 10 feet from the milking shed.

In the case of milking machines, however, the milk room may be under the same roof as the milking bails but shall be separated therefrom by an impervious wall and also separated from the engine room.

The dairy in which the cream is stored must still be at least 10 feet from the milking shed.

Provided the separator and cream room is built in accordance with the plan for the district and the cream room meets the approval of the Inspector, this may be incorporated under the one roof.

(b) It shall be at least 6 feet square and 8 feet in height from the finished floor to the lowest part of the roof or ceiling.

(c) The floor, as in the case of the milking shed, is to be constructed of impervious material which is at least 6 inches above the adjacent ground. Drainage also must be adequate as in the case of the milking shed.

(d) The room shall be ventilated and lighted sufficiently.

(e) Exterior openings are to be fitted with fly-proof screens.

(f) The walls and roof shall be constructed of approved materials unless constructed of stone, brick, or concrete.

Approved materials are asbestos preparations, iron, or wood, and an Inspector may require same to be painted where necessary.

(g) The internal wall surfaces, the ceiling, or, in those cases where a ceiling is undesirable, the underside of the roof shall be covered with hard, smooth, and impervious material, such as asbestos or smooth iron; wood is unsuitable. Such wall shall be finished so as not to afford any lodgment for dirt.

(h) Any shelves, benches, racks, etc., shall be made of smoothly dressed wood or other approved material and so arranged that they may be removed for cleansing purposes. Iron piping has proved both sanitary and convenient for the making of shelves and racks.

(i) The milk room or dairy shall not be used for any purpose other than the handling or housing of milk and the storage of milk vessels.

(j) The farmer, when required to do so, shall pave the ground immediately surrounding the milk room with a layer of not less than three inches of approved material and to a width of at least six feet.

(k) The room shall be equipped with milk strainers of approved material and design, and with an approved cooler which shall be properly connected with a cold water supply.

(l) Every dairy farmer is required to maintain his buildings, drains, fittings, machinery, utensils, tools and appliances in good repair and in a cleanly condition.

(m) Every vessel, receptacle, utensil, or other article used for manipulating milk must be thoroughly cleansed immediately after it has been used, and sterilised with steam or clean boiling water immediately before again being used. This is most important and infers that a liberal supply of boiling water will be available at the dairy for cleansing purposes. The minimum that will be accepted is a copper which is used for the provision of boiling water and is situated at the dairy.

The practice of boiling water some distance from the dairy and carrying this out to the place selected for washing dairy equipment is to be discontinued.

14. *Disease—Human.*—When a case of infectious disease affecting any member of the family or staff occurs, the same shall be reported immediately to the Local Health Authority. No affected person or one who is a contact with any infectious disease shall engage in any work on dairy premises.

15. *Disease—Stock.*—Any case of sickness or disease amongst dairy stock shall be reported immediately.

Agricultural Problems.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser or Veterinary Officer of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	A. T. Gulvin (Fruit).
Bridgetown	A. M. Tindale (Dairying), A. Flintoff (Fruit).
Bunbury	M. Cullity (Dairying), A. F. Flood (Stock Diseases).
Busselton	J. M. Nelson (Dairying).
Denmark	C. W. Tobin (Dairying), B. C. Bignold (Stock Diseases).
Geraldton	N. Davenport, c/o. Government Buildings.
Gosnells	R. C. Owen (Fruit).
Harvey	R. C. Cailes (Fruit).
Katanning	A. S. Wild.
Kalamunda, Roleystone ..	W. R. Jamieson (Fruit), c/o. Dept. of Agriculture, Perth.
Kellerberrin	F. V. Knapp.
Manjimup	J. T. McNally (Dairying), T. F. Herlihy (Fruit).
Margaret River	A. L. Hamilton (Dairying), R. Harley (Stock Diseases).
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